A Comprehensive Data-Driven Analysis of Talent Supply using Delphi Method in Higher Vocational Education and Ethnic Minority Regions

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Abstract

This study delves into the principles of structural reforms on the supply side of talent in higher vocational education, specifically focusing on the context of Guangxi, China, and extending its applicability to diverse ethnic regions. Embracing a data science approach, the research aims to develop a model grounded in theoretical foundations and policy considerations, offering insights to enhance the higher vocational education system and facilitate a high-quality talent supply. The research sample comprises 28 experts who contributed 182 perspectives on the constituent elements of higher vocational education reform in ethnic minority areas. Leveraging the Delphi method, the study employs qualitative evaluation methods through anonymous questionnaire surveys to ensure reliable feedback. A comprehensive survey includes 391 participants representing various stakeholders, such as the education department, teachers, industry experts, and students. Utilizing mathematical statistics and SPSS AU22.0 for data analysis, the study confirms that adaptation indicators meet established standards, aligning the theoretical model with measured data. Descriptive analysis and correlation testing of model variables reveal moderate to high average values, indicating a significant positive correlation between the scales. The study explores the layout of universities, major settings, curriculum systems, and talent cultivation as independent variables, with a focus on their influence on vocational talent cultivation. Additionally, it covers the demand side of talents, incorporating perspectives from the government, society, students, and parents. The analysis assesses the satisfaction of the supply side of higher vocational education, exploring specific manifestations of the contradiction between talent supply and demand. Through attribution analysis, the study concludes by proposing considerations for the supply-side structural reform of higher vocational education talents in Guangxi and similar ethnic regions. This research, rooted in data science methodologies, provides valuable insights for educational policymakers and practitioners. It sets the stage for further exploration into the dynamic interplay between data-driven decision-making and structural reforms in the higher vocational education landscape.

Keywords: Higher Vocational Education Reform, Talent Supply Side, Data Science Methodologies, Ethnic Regions Education, Structural Reforms in Education

1. Introduction

The intersection of vocational education, ethnicity, and economic development forms a complex web that demands attention, particularly within the realm of data science. The intricate relationship between ethnic education and the ethnic economy is a crucial focal point for the education sector. In understanding the future trajectory of vocational education, a specialized analysis that incorporates data science methodologies becomes imperative. The inseparability of vocational education from industrial development in ethnic regions is a key aspect that requires a comprehensive exploration through the lens of data-driven insights [1][2].

The role of higher vocational education for ethnic minorities takes on new dimensions when viewed through the lens of data science. It becomes not only a supplier of labor for economic development but also a driver of scientific and

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technological innovation. The analysis of vocational education's impact on ethnic economies gains depth when considering data-centric limitations in social productivity within ethnic areas. From talent cultivation to educational materials and techniques, a data-driven investigation into the structural reform of the talent supply side becomes essential [3].

Aligning higher vocational education with the economic development needs of ethnic regions is not just a theoretical consideration; it is a data-driven necessity for the modernization of these areas. The pivotal role of education in promoting economic growth is substantiated by a nonlinear autoregressive distributed lag model, revealing the significant contribution of secondary vocational education and training to long-term economic growth. This data-driven insight emphasizes the importance of fostering economic transition prosperity through the encouragement of higher vocational education, particularly in the context of high-tech industries [4].

The academic community in China is actively engaging with the correlation between the evolution of higher vocational education and regional social change. As higher vocational education takes center stage in the context of socialist modernization construction, data-driven research on its theory and practice gains momentum. The evolution of vocational colleges, combined with the external force of heightened demand for high-quality vocational and technical talents, propels higher vocational education into the forefront of economic and social development [5].

In this paradigm shift, data science offers valuable tools for scrutinizing talent cultivation in higher vocational education within ethnic regions. Analyzing the characteristics and trends of development through a data-centric approach aligns with the practical requirements of modernization in these regions. The unique economic and social dynamics of Guangxi, for instance, necessitate a data-driven approach to examine talent supply and structural reform. Understanding the interconnected nature of economic and educational progress in Guangxi becomes imperative, urging the formulation of effective talent training strategies to meet the demands of urbanization [6].

2. Literature Review

2.1. Issues in Higher Vocational Education in Ethnic Regions within the Realm of Data Science

The intricacies of higher vocational education in ethnic regions are undeniably intertwined with the economic landscape, presenting a rich field for exploration through the lens of data science. The economic progress of these areas, driven by the development of vocational education, unveils a spectrum of challenges that are ripe for data-driven analysis. The manifestations of these issues include a misalignment between the professional settings of vocational colleges and local industrial development, resulting in a stark disparity between talent supply and demand in the human resources market. This misalignment, quantifiable through data, has significant implications for the stability rate of student employment [7].

The quality of talent cultivated in vocational colleges, another aspect calling for data scrutiny, often falls short of enterprise needs. Data-driven insights can illuminate the gaps, guiding additional training strategies to enhance alignment. The singular trajectory of vocational education, marked by government dependence and limited market participation, is a nuanced challenge that can be dissected through data analytics. Societal recognition of vocational education, a vital aspect for its elevation, can be measured and influenced through targeted data-driven interventions [8].

Concerns about the relatively low quality of students in vocational colleges, a pivotal factor for sustainable development, merit a comprehensive data-driven assessment. The growth potential for higher vocational education, captured through data on program levels and offerings, reveals critical insights into the landscape. Stakeholder motivation and collaborative mechanisms, fundamental for successful reform, can be quantified and optimized through data-driven strategies. Applied talent training models, systems, and mechanisms for mutual benefit within industries and enterprises can be envisioned and measured through sophisticated data analyses [9].

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2.2. Research on the Current Situation of Higher Vocational Education in Ethnic Regions: A Data-Centric Perspective

McGrath and Yamada [10] exploration of the state of vocational education institutions in ethnic minority areas, highlighting disparities in teaching equipment, professional settings, and teaching staff, lends itself to a data-centric approach. Attention to key elements such as the campus environment, teaching equipment, philosophy, and cultural atmosphere can be quantified through data analysis, offering a nuanced understanding of the existing disparities. Dai et al. [11] assertion of an asymmetry between talent supply and market demand, resulting in employment difficulties for graduates, can be validated and addressed through data-driven strategies. Baijnath et al. [12] call for a comprehensive analysis of the industrial structure's impact on higher vocational education finds resonance in the data science realm, enabling a deeper understanding of the societal labor shortage and potential solutions.

Hua [13] emphasis on shortcomings in enrollment, teaching, and employment choices within vocational education institutions gains precision through a data-driven lens. The lack of initiative in school-enterprise cooperation and industry-education integration can be quantified and targeted for improvement through data analysis. A data-centric exploration can unravel the underlying patterns and correlations in vocational education in ethnic regions, shedding light on potential areas for improvement.

2.3. Research on the Reform of Talent Training in Higher Vocational Education in Ethnic Regions: A Data-Driven Paradigm

The influential theoretical models in vocational education, such as the German dual system, the British apprenticeship system, the supply and demand linkage mechanism model, and the industry-education integration model, offer a rich landscape for data-driven exploration. Originating from Germany, the dual system's impact on career options for students can be analyzed quantitatively, allowing for a nuanced understanding of its effectiveness. The challenges faced by the British degree apprenticeship system in China, including increased costs and risks for companies, can be quantified through data, providing valuable insights for decision-makers [14].

Liu [15] advocacy for integrating schools into regional development and strengthening partnerships with universities can be quantitatively assessed for its impact on cultivating high-quality technical talents. The industry-education integration model, a core approach in higher vocational education, can be analyzed through data to measure its effectiveness and potential areas for improvement. Zhou et al. [16] supply and demand linkage mechanism model, emphasizing comprehensive supply to meet various demands, can be explored through data analytics to uncover the interaction relationship between the supply and demand sides in China.

In summary, a data-driven perspective offers a powerful lens to delve into the intricate issues of higher vocational education in ethnic regions, providing nuanced insights and actionable strategies for reform and improvement.

3. Method

3.1. Population

The research population, comprising 1690 individuals, forms the basis for a comprehensive data-driven analysis. The diverse composition includes various stakeholders in vocational education, encompassing professional leaders (teachers) in both vocational and secondary vocational colleges, teachers responsible for employment work, government personnel overseeing higher vocational education, graduates with varying work experience durations, current vocational students, parents of graduates and students, and enterprise employees [17]. Additionally, the inclusion of 50 education management personnel responsible for ethnic minority areas broadens the scope of the study.

To ensure a representative and statistically significant dataset, a systematic sampling strategy will be employed. Random sampling methods will be applied within each subgroup to guarantee unbiased representation. This approach aims to capture the perspectives and experiences of different stakeholders, providing a holistic view of the intricacies within higher vocational education in ethnic regions.

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Quantitative and qualitative data will be collected using a combination of structured surveys, interviews, and document analysis. The surveys will be designed to gather numerical insights and opinions from the participants, allowing for statistical analysis. Interviews will provide a deeper understanding of qualitative aspects, such as personal experiences and perceptions. Additionally, relevant documents, including official reports and academic publications, will be analyzed to enrich the data pool [18].

The collected data will undergo rigorous analysis using advanced statistical methods and data science techniques. Descriptive statistics will be employed to present a snapshot of the overall trends within the population. Inferential statistics, including regression analysis and hypothesis testing, will be applied to derive meaningful insights and correlations. Text mining and sentiment analysis will be utilized to extract valuable qualitative information from interviews and open-ended survey responses.

Ethical guidelines and standards for data collection and analysis will be strictly adhered to. Informed consent will be obtained from all participants, ensuring their voluntary participation and confidentiality. The research design will prioritize the privacy and well-being of individuals, aligning with ethical principles in data science research.

This methodological approach, blending traditional survey methods with advanced data science techniques, aims to provide a comprehensive and nuanced understanding of the issues within higher vocational education in ethnic regions. The combination of quantitative and qualitative data, coupled with robust sampling and ethical considerations, positions this research to contribute valuable insights to the field of data-driven educational analysis.

3.2. Sample Size and Sampling Method

This paper employs the probability sampling technique Li et al. [19], as the main respondents are randomly selected individuals coming to Guangxi, China. The Cochran formula [20] is referenced for sample size calculation when the exact number of people cannot be clearly determined. The formula used for calculation is as follows:

$$Z\alpha/2\ \frac{s}{\sqrt{n}} = e \Longrightarrow \quad n=\left(\frac{Z\alpha/2\sigma}{e}\right)2$$

(n-sample capacity, e-error range, Z-confidence level, σ-Overall standard deviation, S-Sample standard deviation) In the formula, n represents the sample size, Z represents the confidence level, and e represents the allowable error range. Due to the inability to calculate the proportion of each specific group in the selected population in this article, it is assumed that the proportion is 0.5. That is to say, the maximum proportion of this attribute in the population can be 0.5, and the minimum can be 0.5. In this study, the confidence level was 95%, and the allowable error range was 5%. The sample size calculated according to the formula is 354.51, which means 355 samples should be selected. To prevent erroneous factors in questionnaire collection, the sample size was 360 samples, so we collected more than 10% of the samples, which means we calculated 36 cases, totaling 391 cases. The selection of respondents is random, and their privacy will be protected. The interviewee's name will not appear. Their opinions will only be used for academic research purposes.

3.3. Research Tools

1) Questionnaire Survey

Utilizing the China Questionnaire Star software for implementing questionnaires and conducting internet-based content surveys proves to be more convenient and time-efficient. The questionnaire consists of three main parts, as detailed in Appendix 1, 2, and 3, and respondents are required to provide answers using the Likert scale [21][22].

Type A questionnaire: Recognition of vocational education, comprising a total of 15 questions.

Type B questionnaire: A market survey on satisfaction with vocational education teaching and management, consisting of 19 questions.

Type C questionnaire: A survey on the indicators that ideal vocational education should possess, comprising a total of 40 questions.

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2) Expert Interviews

Part 1: Interview Outline (Teacher), featuring 12 questions.

Part 2: Interview Outline (for current students), including 22 questions.

Part 3: Interview Outline (Graduates), comprising 18 questions.

Expert interviews are conducted in two stages:

Phase 1: Establishing 52 questions, primarily consulting experts on the constituent elements of major offerings, course offerings, and teaching quality.

Phase 2: Interview content involves the satisfaction index system of the vocational education framework initially set by the author, based on the questionnaire survey and results from the first stage expert interviews. Currently, the Delphi method and Likert scale are employed to conduct three rounds of questionnaire surveys with experts. The primary goal is to seek expert opinions and suggestions on the scientific, reasonable, and operationally sound setting of the indicator system, leading to revisions and improvements

3.4. Framework

This study employed a hybrid approach by integrating the industry-education integration model and the supply-demand linkage model, harnessing their respective strengths while circumventing their limitations. From an economic perspective, the study embraced a third-party evaluation viewpoint and adopted a closed-loop structure comprising an evaluation system, actual verification, and feedback suggestions. This method emphasized the assessment of both the process and outcomes of talent development. Additionally, a talent cultivation supply and demand model was established, grounded in practical applications and feedback suggestions. This model systematically analyzed the indicator system for the structural reform of higher vocational talent cultivation in ethnic regions, as illustrated in Figure 1:

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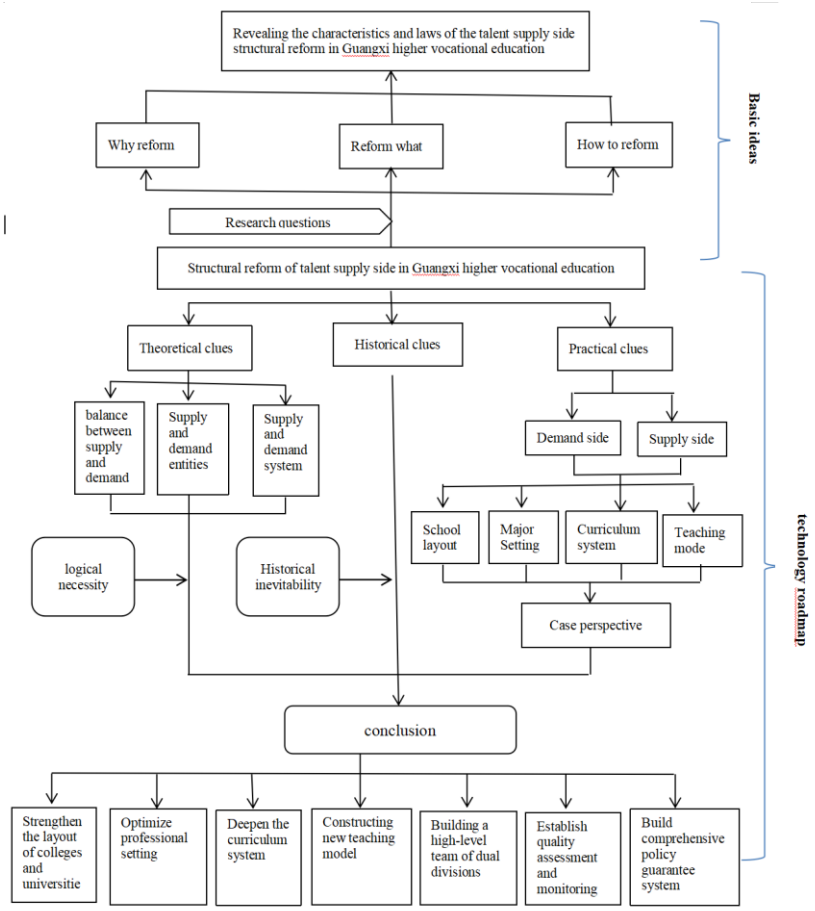

Figure 1. Framework

This study centers on the theme of structural reform in the cultivation of higher vocational talents in ethnic regions. Utilizing the fundamental principles of higher education and employing research methods from educational economics, it delves into the necessity, reality, and inevitability of the emergence and evolution of higher vocational education in serving social and economic development. The layout of universities, professional settings, and curriculum systems—the four foundational elements influencing and determining the quality of talent cultivation in higher vocational education, specifically, the talent cultivation model—serves as independent variables for research. The analysis extends to the demands of key stakeholders on the talent demand side, including the government, society, students, and parents, alongside an assessment of the satisfaction of the supply side of higher vocational education. The study explores the specific manifestations of the contradiction between talent supply and demand, conducts attribution analysis, and concludes by proposing considerations for the supply-side structural reform of higher vocational education talents in Guangxi and similar ethnic regions.

3.5. Research Process

This study concentrates on the reform of talent cultivation in higher vocational education in ethnic regions, with Guangxi as a representative case. The investigation aims to uncover the laws and characteristics of the supply-side structural reform of higher vocational education talents in ethnic regions, employing the Delphi method. The research involves expert interviews and questionnaire surveys to gather data for the Delphi process, employing both quantitative and qualitative methods for data collection, analysis, and statistics. The process unfolds through four key steps:

Step 1: A comprehensive expert discussion meeting is conducted to formulate predictions for talent cultivation indicators and standards in higher vocational education within ethnic regions. Opinions from 28 experts in the field are solicited through public and anonymous means. Expert opinions are compiled, organized, and classified. Based on the

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results and literature on higher vocational education, 52 elements constituting the theoretical system indicators for talent cultivation reform are identified and included in the first interview questionnaire.

Step 2: The first interview questionnaire, designed based on expert opinions, is utilized to gather feedback from the same group of 28 experts. After considering this feedback and identifying unnecessary factors, elements are removed from the system. The system is revised and improved, incorporating new elements. Corresponding adjustments are made to form the second interview questionnaire.

Step 3: The second interview questionnaire, refined based on feedback from the first round, is used to gather opinions and suggestions again from the same expert group. The indicator system is further improved and adjusted, resulting in the creation of the third interview questionnaire.

Step 4: The third round of the questionnaire survey includes final improvements based on feedback from experts, achieving consensus among them. Consequently, a theoretical indicator system for the reform of talent cultivation in higher vocational education in ethnic minority regions, represented by Guangxi, is established. The reliability and validity of this theoretical indicator system are tested using the Delphi method.

3.6. Statistical Analysis

Upon collecting data from online questionnaires, the Social Science Statistical Software Package (SPSS) was employed for comprehensive data analysis. The analysis unfolded in several steps:

1) Descriptive Statistical Analysis (Section 1):

Stakeholder information, including gender, age, occupation, monthly income, education, and major, was subjected to frequency and percentage analysis.

For Sections 2-4, mean analysis was employed to analyze key factors (mean - $\bar{x}$ and standard deviation - SD) influencing vocational education reform, as indicated on the Likert scale.

2) Inferential Statistical Analysis:

Various statistical techniques, including t-tests, analysis of variance, f-tests, and correlation analysis, were utilized to identify significant factors.

Multiple linear regression analysis was conducted to test factors against the dependent variable.

Pearson correlation analysis was employed to investigate the relationship between independent variables (job and professional correlation, job feedback, career satisfaction, internship satisfaction, training mode, and industry demand integration) and the dependent variable (market demand feedback).

The data analysis was executed using the Social Science Statistics Software Package (SPSS) program version 22, encompassing both descriptive and predictive statistical methods for a comprehensive interpretation of the findings.

4. Result and Discussion

The vocational colleges depicted in the figure serve as both providers of higher vocational education services to the student market and suppliers of higher vocational education products to the job market. They function as primary entities allocating and utilizing social resources, encompassing tangible and intangible resources from various sources, such as government, schools, industries, enterprises, students, and markets. These colleges directly or indirectly offer higher vocational education services and student sources to other educational institutions.

The student source market illustrated comprises high school and vocational school graduates, representing the demand side for higher vocational education services and other forms of higher education. Some directly enter the employment market. The employment market primarily consists of social employers, representing the demand side eagerly awaiting vocational education products and affiliated education products while also contributing to higher education resource provision.

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Social resources, including government, industries, enterprises, social organizations, and markets, constitute the main body of higher vocational education resource allocation. They supply tangible and intangible resources to vocational colleges. Other universities in the figure refer to regular undergraduate institutions, adult universities, self-study exam tutoring institutions, etc. These entities provide education services for the source market and offer education products for the job market. Their relationship with vocational colleges involves obtaining some students, providing educational services, and contributing to a limited number of students.

Vocational colleges integrate and allocate production factors of higher vocational education by receiving social investments, providing opportunities for learners, and cultivating students into higher vocational education products. They act as dual providers of higher vocational education services and products, offering educational services to students and providing higher vocational education products to social employers.

In the context of the supply and demand relationship, students' demand for higher vocational education is viewed as an investment in human capital. Vocational college graduates are considered products of higher vocational education and essential human resources needed by society. The theoretical model of higher vocational education supply and demand encompasses both educational services and products, with services occurring during the education process and products emerging at the end of higher vocational education. This holistic approach emphasizes the dialectical unity of supply and demand, highlighting the foundational role of services in product supply and the driving force of product demand in service provision. Ultimately, the labor and talent market, rather than the source market, plays a decisive role in shaping the development of higher vocational education.

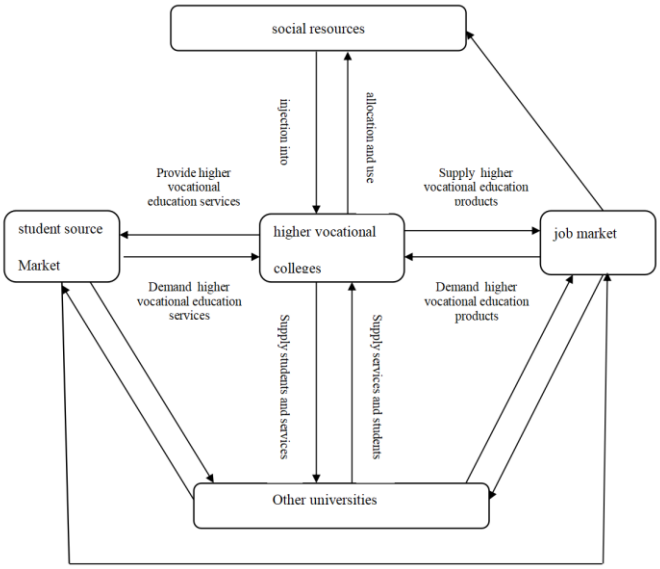

Figure 2. A Talent Cultivation Supply and Demand Model in Higher Vocational Education for Ethnic Regions

5. Conclusion

In addressing the pervasive challenges in the supply of higher vocational education talents across expansive ethnic minority areas, exemplified by Guangxi, this study extends the research paradigm to incorporate principles from the realm of data science. By adopting a data-centric approach, it enriches the research perspective within educational economics and establishes a robust economic analysis system for higher vocational education. Leveraging methodologies from disciplines like economics, educational economics, and higher vocational education, the study delves into an in-depth analysis of the supply and demand relationship between industrial development and higher vocational education in ethnic regions. The examination of the current state of talent cultivation, coupled with an analysis of its underlying reasons, contributes to a broad research framework within the scope of data-driven educational analysis.

Through empirical research, the study demonstrates that approaching higher vocational education from an economic standpoint and employing theoretical frameworks for talent cultivation reform in ethnic regions can effectively address common developmental challenges in vocational education. The research outcomes provide practical guidelines tailored for governments and educational institutions, offering a foundation for enhancing the quality of education and training. The applicability, innovation, and scalability of this model, driven by data science methodologies, endow it with both theoretical and practical significance.

Moreover, the study introduces an evaluation index system model for higher vocational education talent cultivation. Comprising first-level and second-level indicators, this model integrates qualitative and quantitative assessments. The incorporation of practical verification and feedback suggestions establishes a closed-loop evaluation system, suitable for evaluating talent cultivation projects in higher vocational education within ethnic regions. This data-driven approach aids in identifying and resolving issues, thereby fostering the continuous improvement of education and training quality. Beyond its impact on higher vocational education, this model plays a vital role in advancing modernization in ethnic regions and contributing to national unity.

While this study offers valuable insights, it acknowledges certain limitations. Empirical research, constrained by the researcher's level and resource availability, remains a potential area for expansion. The theoretical reasoning and analysis presented form the foundation, with empirical data and analytical support needing further depth. The innovative explorations discussed are initial steps in leveraging data science within this context, and the study encourages future researchers to build upon these foundations for a more comprehensive understanding of the complex dynamics within higher vocational education in ethnic regions.

6. Declarations

6.1. Author Contributions

Conceptualization: L.H., S.B., I.S., and T.S.; Methodology: T.S. and R.C.; Software: L.H.; Validation: L.H. and T.S.; Formal Analysis: L.H., R.C. and T.S.; Investigation: P.S.; Resources: I.S.; Data Curation: P.S.; Writing Original Draft Preparation: P.S. and L.H.; Writing Review and Editing: P.S., R.C. and L.H.; Visualization: L.H. and R.C.; All authors have read and agreed to the published version of the manuscript.

6.2. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

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The authors received no financial support for the research, authorship, and/or publication of this article.

6.4. Institutional Review Board Statement

Not applicable.

6.5. Informed Consent Statement

Not applicable.

6.6. Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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