Article

Construction of Big Data Professional Industry-Education Integration Talent Training System Based on Big Data Application in Hainan Tourism Industry

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Abstract: With the accelerated development of the Hainan Free Trade Port, the regional tourism industry, acting as a fundamental economic pillar, has witnessed an explosive growth in the demand for highly skilled big data professionals, largely driven by ongoing digital transformation initiatives. However, there currently remains a significant and problematic disconnect between traditional academic training methodologies and contemporary industry needs. This gap is characterized by outdated curriculum systems, training programs lacking authentic tourism data support, and superficial school-enterprise collaborations, ultimately resulting in graduates struggling to meet dynamic job requirements promptly. To systematically address the aforementioned challenges, this comprehensive study proposes an innovative, industry-education integration-oriented talent development framework based on the real-world applications of tourism big data within the Hainan Free Trade Port. Centered fundamentally on solving practical industry problems, the research breaks down traditional disciplinary barriers through a robust collaborative mechanism featuring joint school-enterprise development, shared curriculum design, and collaborative talent cultivation, thereby achieving a seamless alignment between the educational and industrial chains. Specifically, the study establishes a modular curriculum system deeply integrated with tourism business logic, effectively transforming real-world enterprise projects—such as tourist behavioral profiling and regional traffic forecasting—into highly valuable teaching resources. Simultaneously, a comprehensive industry-education integration platform combining teaching, empirical research, and social services has been successfully developed. This integrated system not only effectively resolves the persistent dilemma of disconnected academic and corporate environments but also provides targeted, high-quality talent support for the sustainable development of the Hainan Free Trade Port, demonstrating significant practical applicability and promotion value.

Keywords: big data; tourism industry; education integration; talent development; curriculum design

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1. Introduction

The Hainan Free Trade Port has identified tourism as a pivotal industry, with digital transformation serving as the central pathway for industrial advancement. As mobile internet and IoT technologies increasingly integrate into the sector, they generate vast amounts of multi-source heterogeneous data across tourism supply chains. This makes big data technology an essential tool for improving service efficiency and operational effectiveness [1, 2]. However, a significant disparity exists between the digitalization of the industry and the availability of skilled talent. University education continues to follow traditional computer science paradigms, with curricula that are disconnected from the specific needs of the tourism industry. These programs often lack real-world data and fail to incorporate practical business scenarios, resulting in graduates who are not adequately prepared to meet corporate demands. This misalignment hampers the intelligent

upgrading of the industry and highlights structural deficiencies in the mechanisms that link education and industry. To address these challenges, it is imperative to establish a big data talent cultivation system that is guided by the specific demands of the industry and deeply integrated with tourism scenarios. Such a system would bridge the gap between education and industry, ensuring a steady supply of skilled professionals capable of driving digital transformation in the tourism sector.

Current domestic research on big data talent cultivation predominantly emphasizes general technical optimization, while studies tailored to the unique needs of regional industries remain underdeveloped. The practice of integrating industry and education often lacks depth, with school-enterprise collaborations limited to superficial initiatives such as "order-based training programs." These efforts fail to achieve meaningful synergy between academic institutions and businesses. Furthermore, teaching content frequently lags behind the rapid pace of technological advancements, leaving students without exposure to authentic industry cases or practical applications. Enterprises, on the other hand, often lack sufficient incentives to actively participate in educational initiatives, which prevents the establishment of a robust, multi-stakeholder collaborative education ecosystem. This disconnect results in a significant misalignment between the skills developed through academic programs and the competencies required by the job market. Addressing these issues requires a comprehensive approach that fosters deeper collaboration between educational institutions and enterprises, ensuring that curricula are updated to reflect the latest technological trends and industry needs. By doing so, the gap between talent development and market demands can be effectively narrowed, creating a more dynamic and responsive talent pipeline.

This study focuses on addressing the digital transformation needs of the tourism industry in the Hainan Free Trade Port through a combination of literature review, case analysis, and field research. It explores the application of big data in representative tourism enterprises and identifies the core competencies required for key positions within the sector. By leveraging Hainan's "Peak Employment, Off-Peak Education" policy and drawing on existing industry-education collaboration experiences, the research proposes a talent development framework characterized by data-driven methodologies, scenario-based integration, and progressive skill enhancement. The framework emphasizes the use of authentic tourism data as a foundation for reconstructing modular curricula, developing collaborative training platforms, and innovating a "dual-teacher co-education" mechanism [3]. This approach ensures precise alignment between educational programs and the specific demands of the industry, enabling the production of highly skilled big data professionals who can be immediately deployed in the Free Trade Port. Additionally, the framework provides replicable practical models that can be adapted to other regions and industries, thereby contributing to the broader goal of fostering a sustainable and skilled workforce capable of supporting digital transformation initiatives.

2. Analysis of Big Data Application Scenarios and Talent Demand in Hainan Tourism Industry

2.1. Current Status of Digital Transformation in Hainan's Tourism Industry

With the sustained release of policy dividends from the Hainan Free Trade Port, tourism, as a pillar industry of the regional economy, is undergoing a rapid transition from traditional service models to digitalization and intelligent transformation [4]. The flourishing development of emerging sectors such as duty-free shopping, medical tourism, and exhibition tourism has significantly diversified tourism consumption scenarios while generating vast amounts of high-value data. Concurrently, major scenic spots, hotels, and online travel platforms have increasingly adopted smart management systems to optimize operational efficiency and enhance visitor experiences through data-driven strategies. For example, Sanya International Duty-Free City leverages big data technology to construct detailed consumer profiles, facilitating targeted marketing campaigns and personalized service offerings. Similarly, Tropical Rainforest National Park integrates IoT

and big data technologies to conduct ecological monitoring and implement intelligent crowd management systems. These advancements underscore the pivotal role of data as a core asset within Hainan's tourism industry. The ability to extract and utilize this data effectively has become a critical determinant of industrial competitiveness, driving innovation and enabling businesses to adapt to evolving market demands. As digital transformation accelerates, the strategic application of big data is expected to further enhance the region's tourism ecosystem and economic resilience.

2.2. Typical Application Scenarios of Big Data in the Tourism Industry

Hainan's tourism industry has successfully integrated big data technologies into various operational domains, showcasing innovative applications that enhance efficiency and visitor satisfaction [5, 6]. In the realm of visitor services and marketing, businesses utilize multi-source data, including demographic information, occupational profiles, consumption behaviors, and social media interactions, to construct detailed user profiles. These profiles enable the delivery of personalized product recommendations and the execution of targeted advertising campaigns, which have proven effective in increasing conversion rates. For scenic area management and safety systems, predictive models are developed using historical visitor flow data, weather conditions, and traffic patterns. These models generate real-time alerts for peak crowd situations, facilitating proactive measures to prevent incidents such as stampedes and ensuring effective crowd control. In brand management and public sentiment analysis, advanced web crawling tools collect unstructured data from online reviews and travel diaries, while natural language processing technologies analyze visitor emotions to identify service deficiencies and uphold brand reputation. Additionally, within the integrated tourism framework, efforts are underway to establish cross-regional and interdepartmental data-sharing mechanisms. By analyzing tourist movement patterns, resources for transportation networks, accommodation facilities, and dining establishments are being optimized, leading to improved operational efficiency and a seamless travel experience for visitors.

2.3. Industry Competency Requirements for Big Data Professionals

These application scenarios necessitate professionals who possess a hybrid competency framework that integrates both technological expertise and business acumen. Practitioners are required to master essential data acquisition and governance skills, such as effectively utilizing web scraping tools to gather online travel data and employing advanced techniques like data cleaning, deduplication, and standardization to process unstructured information. Additionally, they must demonstrate strong capabilities in data analysis and modeling, including proficiency in programming languages like Python and R, as well as the application of machine learning algorithms to develop user profiling models and traffic prediction systems [7]. Beyond technical skills, a deep understanding of the operational dynamics of the tourism industry chain is critical. Professionals must be able to align technical solutions with specific business challenges, crafting data-driven strategies that address key pain points. Furthermore, the ability to present complex analytical results through data visualization tools, such as charts and dashboards, is essential for supporting managerial decision-making. This comprehensive competency structure is particularly aligned with the core talent demands of Hainan's tourism digital transformation efforts, ensuring that professionals can effectively contribute to the region's strategic initiatives.

3. Principles for Constructing an Industry-Education Integration Talent Cultivation System in Big Data Specialization

3.1. Principle of Industry Demand Orientation

The development of talent cultivation systems must prioritize the practical needs of Hainan's tourism digital transformation as its core foundation. This approach necessitates moving away from traditional "discipline-oriented" closed models and embracing an open paradigm centered on "job roles" and "competency development." By implementing

regular industry research mechanisms, it becomes possible to dynamically identify competency standards for critical positions such as tourism data analysts and business intelligence engineers [3, 8]. This process involves creating an "industry talent demand inventory" that serves as a guiding framework for curriculum design and instructional content. For example, addressing skill requirements for roles like tourist profiling and scenic area visitor flow forecasting within Hainan's tourism sector requires breaking down core competencies such as data collection and machine learning modeling into specific teaching modules. These modules ensure that students acquire targeted skills aligned with industry demands. This alignment facilitates the achievement of the educational objective of producing graduates who are immediately employable and capable professionals upon entry into the workforce. Furthermore, this system supports the seamless integration of academic training with practical industry applications, fostering a robust connection between education and employment outcomes.

3.2. Principle of Collaborative Education between Schools and Enterprises

Breaking down the physical barriers between schools and enterprises, a collaborative education mechanism with dual stakeholders is established, transforming enterprises from mere "internship base providers" into active "talent development partners." Enterprises are encouraged to engage comprehensively in the talent cultivation process, encompassing curriculum design, course development, textbook compilation, and teaching implementation. For example, they can co-develop specialized courses such as "Practical Tourism Big Data Analysis" and "Smart Scenic Area Data Management," where real-world projects are converted into practical teaching cases. The implementation of a "dual-mentor system" ensures that academic faculty focus on developing theoretical frameworks, while industry mentors provide guidance on practical skills. Additionally, the two-way rotation model, where faculty members take on corporate roles and engineers deliver classroom instruction, fosters an immersive training environment. This approach allows "teachers to become engineers and students to become employees," thereby achieving a profound integration between educational and industrial chains. Such a model not only enhances the practical relevance of education but also ensures that students are better prepared to meet the demands of the modern workforce.

3.3. Principle of Progressive Competency

Adhering to the developmental trajectory of technical professionals, a structured and tiered training framework has been established to guide students from foundational learning to advanced application and innovation [9, 10]. In the initial stages, freshmen concentrate on acquiring a robust understanding of big data theories and mastering essential tools, ensuring a strong foundation in mathematics and programming. As students progress to intermediate levels, they engage with practical case studies derived from Hainan's tourism enterprises, enabling them to develop industry-specific skills and apply theoretical knowledge to real-world scenarios. At the senior level, students participate in immersive on-the-job internships and undertake comprehensive graduation projects. These experiences involve direct engagement with corporate research and development initiatives, allowing students to address complex engineering challenges. This progressive approach facilitates a seamless transformation from technical novices to proficient industry professionals, equipped with both theoretical expertise and practical experience.

3.4. Principle of Openness and Sharing

Leveraging the strategic advantages provided by the Hainan Free Trade Port, an open sharing platform will be established to foster collaboration among government entities, industry stakeholders, academic institutions, and enterprises. This initiative aims to integrate diverse resources, including government industrial data, standardized technical frameworks, real-world corporate projects, and educational materials from schools, to create the Hainan Tourism Big Data Sharing Center. By incorporating desensitized tourist consumption data and operational metrics from scenic areas into

academic institutions, the platform will provide authentic and valuable data support for teaching and research activities. Faculty and students will be encouraged to actively participate in social services, applying research findings to practical scenarios [11]. This approach promotes the bidirectional flow and optimized allocation of educational resources and industrial assets, ultimately enhancing productivity and fostering innovation across sectors.

4. Talent Cultivation Goal Positioning Based on Industry-Education Integration

4.1. Overall Training Objectives

This program is designed to meet the strategic needs of the digital economy and the development of smart tourism within the framework of Hainan Free Trade Port construction. By adopting industry-education integration as its central methodology, the program seeks to cultivate versatile, application-oriented technical professionals who demonstrate comprehensive development across moral, intellectual, physical, aesthetic, and labor education. Graduates will possess robust technical competencies in big data, alongside a deep understanding of industry-specific requirements. They will systematically master the complete spectrum of big data technologies, including collection, storage, processing, analysis, and visualization. Furthermore, they will acquire profound insights into the operational dynamics of the tourism industry chain and the demands of digital transformation. This expertise will enable them to excel in areas such as data-driven decision-making, precision marketing, intelligent management, and service optimization. Graduates will be prepared to contribute effectively across various scenarios, including tourism administrative departments, scenic areas, online travel agencies, and tourism e-commerce platforms [10]. Ultimately, the program aims to produce high-caliber professionals equipped with innovative thinking, practical expertise, and the ability to drive industry advancements through data-driven approaches.

4.2. Specific Physical Requirements

Regarding specific competency requirements, it is imperative to establish a comprehensive tripartite training framework that integrates knowledge, skills, and professional qualities. At the knowledge structure level, the focus should be on strengthening foundational theories in mathematics, statistics, and computer science while ensuring mastery of core big data technologies. This framework must also incorporate industry-specific knowledge, particularly related to Hainan's tourism development policies, market dynamics, and service standards. Such an interdisciplinary knowledge system is essential for combining technical expertise with practical industry applications. For skill development, emphasis should be placed on cultivating advanced practical competencies, including proficiency in big data platform operations, data mining methodologies, machine learning techniques, and the design of tourism data visualizations. Furthermore, students should develop robust problem-solving capabilities by integrating technological solutions with real-world challenges in the tourism sector [12, 13]. In terms of professional qualities, it is crucial to foster strong professional ethics and a spirit of craftsmanship. Additionally, cross-cultural communication skills and a global perspective are vital to meet the international demands of free trade ports. Essential attributes include teamwork, effective communication, and a commitment to continuous learning, enabling individuals to adapt to the rapid technological advancements shaping the industry.

5. Core Content Design of Talent Cultivation System

5.1. Restructuring of the Curriculum System Integrating "Job-Course-Competition-Certificate" Framework

We have developed a modular curriculum framework that integrates a "basic platform + core modules + extension directions" structure to enhance the talent cultivation system. The foundational platform is designed to strengthen mathematical and programming skills through courses such as advanced mathematics, linear algebra,

probability theory, Python programming, and database principles. Core modules focus on essential technical competencies, including big data collection and web crawling, data cleaning and preprocessing, Hadoop development, Spark in-memory computing, machine learning and data mining, and data visualization. To address industry-specific needs, the tourism application extension module incorporates specialized courses such as tourism data analysis practices, tourism e-commerce and recommendation systems, and smart tourism system development, with a particular emphasis on Hainan case studies. Additionally, a semester-long course review mechanism ensures the timely integration of emerging technologies, such as privacy-preserving computing and generative AI, into the curriculum. This dynamic approach aims to equip students with cutting-edge skills and knowledge, fostering adaptability and innovation in rapidly evolving fields.

5.2. Development of "dual-Qualified Dual-Skilled" Faculty Team

Through the strategic approach of "domestic cultivation and external recruitment," efforts are made to establish a teaching team that integrates theoretical knowledge with practical expertise. This initiative involves inviting experienced professionals, such as technical directors and data analysts from tourism enterprises, to contribute as adjunct professors or industry mentors [4]. To ensure continuous professional development, the faculty implementation system mandates that professional educators engage in at least six months of corporate internship experience within every five-year period. Furthermore, collaboration between academic institutions and enterprises is actively promoted to foster the creation of joint research and development studios. These partnerships aim to undertake tourism big data research projects and enhance the technical service capabilities of the faculty, thereby bridging the gap between academia and industry.

5.3. A Practical Teaching System Integrating Virtual and Real Elements

A comprehensive three-in-one practical teaching system is established, integrating "on-campus training, off-campus bases, and innovation and entrepreneurship." On-campus, a state-of-the-art virtual simulation training center is developed to facilitate data monitoring exercises. These simulations replicate real-world scenarios, such as managing peak passenger flows at airports, train stations, and popular tourist destinations. The system incorporates advanced enterprise-level big data experimental platforms, including Huawei Cloud and Alibaba Cloud, to provide students with hands-on experience in data analysis and decision-making. Off-campus, partnerships are formed with organizations such as Hainan Tourism Investment Holding Group, Sanya International Duty-Free City, Tuniu, and Tongcheng Yilong. These collaborations implement a "2.5+0.5+1" work-study alternating model, allowing students to gain practical industry exposure. Additionally, students are encouraged to participate in prestigious competitions, including the China College Student Computer Design Competition, the "Challenge Cup," and "Internet+" events. These activities promote the application of Hainan tourism data for innovative problem-solving, enhancing students' abilities to address complex challenges effectively.

6. Mechanisms and Operational Models for Industry-Education Integration Assurance

6.1. Collaborative Education Mechanism of Government-Industry-School-Enterprise Partnership

A quadrilateral collaborative education mechanism is proposed, emphasizing the roles of government leadership, industry guidance, school-centered initiatives, and corporate participation. At the governmental level, authorities are expected to implement targeted support policies, establish dedicated funds for industry-education integration, and provide financial incentives such as tax benefits or subsidies to enterprises actively involved in school-enterprise cooperation. Additionally, universities demonstrating exceptional achievements in this domain may receive recognition and rewards. At the industry level, the formation of an industry-education integration alliance is envisioned, with leading enterprises taking the initiative to develop professional standards and job specifications. These efforts aim to provide a scientific basis for talent cultivation and align educational outcomes with industry needs. At the institutional level, schools will establish

specialized industry-education integration offices under academic leadership to coordinate partnerships, dismantle departmental silos, and optimize resource allocation across campuses. Enterprises, on the other hand, will play a pivotal role by contributing real-world project resources, advanced technological platforms, and part-time mentor teams. Their involvement will span the entire talent development process, including curriculum design, course development, and teaching implementation. This comprehensive approach seeks to foster effective collaboration between schools and enterprises, ensuring that education aligns closely with practical industry demands.

6.2. Resource Sharing and Platform Construction

The Hainan Tourism Big Data Industry-Education Integration Cloud Platform is designed to consolidate anonymized data resources from the provincial tourism sector, creating a unified and comprehensive system that integrates teaching, research, and service functionalities [14]. This platform aims to support academic institutions by facilitating educational and scientific research activities while simultaneously offering technical solutions tailored to the needs of enterprises. Furthermore, the initiative seeks to foster industry-academia collaboration by partnering with leading enterprises to establish the "Smart Tourism Industry College." This collaboration will implement modern apprenticeship programs, ensuring a seamless integration of student recruitment processes with workforce enrollment strategies. Such efforts aim to bridge the gap between academic training and practical industry requirements, enhancing overall efficiency and innovation.

6.3. Diversified Quality Evaluation System

Reforming the traditional evaluation system, which has been predominantly centered on exam scores, is essential to establish a competency-oriented and diversified assessment framework. A process-oriented evaluation approach emphasizes students' performance during project-based training and corporate internships, with increased weighting given to evaluations conducted by industry mentors. This ensures that practical skills and real-world applications are prioritized. An outcome-based assessment method integrates students' tangible project achievements, vocational skill certifications such as Big Data Engineer certifications, and the publication of technical reports into the evaluation criteria. Additionally, third-party evaluations involve industry organizations or professional assessment agencies conducting follow-up surveys on graduate employment quality and career progression. The feedback obtained from these surveys is instrumental in refining and improving talent cultivation programs, ensuring alignment with industry demands and fostering long-term career success [1].

7. Conclusion

The development of Hainan Free Trade Port has opened up transformative opportunities for fostering big data professionals tailored to the tourism sector. This study introduces an industry-education integrated talent development framework specifically designed to leverage Hainan's tourism big data applications, adhering to the guiding principle of "industry demand orientation." The framework is structured around three pivotal strategies: restructuring curriculum systems to align with evolving industry needs, innovating collaborative mechanisms to strengthen partnerships between academia and industry, and enhancing practical teaching to ensure students gain hands-on experience with real-world applications. These approaches collectively aim to resolve the persistent structural mismatches between the supply of skilled talent and the demands of the tourism industry, thereby creating a more cohesive and responsive educational ecosystem.

The implementation of this framework is expected to provide robust talent support for the digital transformation of Hainan's tourism industry, significantly elevating the intelligence and efficiency of tourism services. Furthermore, it will contribute to the connotative development of big data disciplines within universities, fostering a deeper integration and seamless alignment between education chains, talent chains, and industrial chains. As technological advancements accelerate and industrial upgrades

deepen, the framework will undergo continuous optimization and iterative updates to remain adaptable to the evolving requirements of Hainan Free Trade Port construction. This dynamic adaptability will ensure that the framework not only meets immediate needs but also anticipates future challenges, thereby contributing to the sustainable and high-quality growth of the regional digital economy. Future research could explore the scalability of this framework to other regions and industries, as well as investigate the long-term impacts of such integrated systems on workforce readiness and economic development.

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