RAYS-Based Technological Innovation Model and Its Impact on Publishing Convergence: Post-Print

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Abstract

For the publishing industry, long-standing issues such as supply-demand mismatch, overcapacity, and reader attrition persist. Against the backdrop of current media convergence development, traditional publishing models are no longer adequate to meet the pressing demand for enhancing market competitiveness within the publishing sector. This paper first examines the current state and existing challenges confronting the integrated development of the publishing industry; subsequently, it analyzes the technical architecture of the RAYS system and the functionalities of its key technologies, while elaborating on its positive impacts on publishing convergence. The paper provides a comprehensive analysis of how the RAYS system facilitates deep integration of traditional publishing across content, channels, platforms, operations, and management, and how it constructs a novel internet-based knowledge service ecosystem.

Full Text

Preamble

Title: The RAYS-Based Technical Innovation Model and Its Impact on Publishing Integration

Abstract: The publishing industry has long grappled with issues such as supply-demand mismatch, overcapacity, and reader attrition. Against the backdrop of ongoing media convergence, traditional publishing models are no longer adequate to meet the industry' s urgent need for enhanced market competitiveness. This paper first analyzes the current state and challenges facing integrated development in the publishing sector. It then examines the technical architecture of the RAYS system and the functions of its key technologies, elaborating on their positive impact on publishing integration. The paper provides an in-depth

analysis of how the RAYS system promotes deep integration of traditional publishing across content, channels, platforms, operations, and management, and how it constructs a new internet-based knowledge service ecosystem.

Keywords: RAYS; publishing integration; technical innovation; big data; cloud computing

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1.1 Single Profit Model

For a long time, publishing units have relied on bookstore sales and order channels to sell books. This traditional promotion and sales model has resulted in a single profit model for publishing units. In the era of media-diversified mobile internet, users have access to a wide range of media channels, leading to massive user attrition and making profitability even more difficult. According to the "2017-2018 China Digital Publishing Industry Annual Report," the proportion of digital revenue from traditional books, newspapers, and periodicals continues to decline. In 2017, the total revenue of internet journals, e-books, and digital newspapers was 8.27 billion yuan, accounting for 1.17% of total digital publishing revenue, continuing its downward trend compared to 1.54% in 2016 and 1.77% in 2015.

Under the impact of the previous digital wave, traditional publishing has insufficient control over content resources, with digital authorization issues limiting its development. On the other hand, due to technological and conceptual limitations, the traditional publishing industry struggles to achieve the transformation from resources to value, resulting in an industry that is large but not strong. At present, the application of digital publishing resource platforms is relatively widespread in China, with most publishing units using digital resource processing management platforms in their digital convergence transformation. The widespread application of these technologies has simplified content production processes. However, they still cannot solve the fundamental problems facing traditional publishing.

1.2 Insufficient Innovation Capability and Low Efficiency in Knowledge Resource Organization

From the supply perspective, some publishing units lack innovation awareness, leading to blind publishing, copycat publishing, and repetitive publishing. A large volume of published books deviates from actual reader demand, resulting in inventory backlogs that not only cause direct financial losses but also consume human resources. Furthermore, although publishing units possess massive content resources, they cannot effectively utilize or realize their value. With institutions operating in isolation and content resources scattered and lacking effective integration, resource utilization efficiency remains low.

The concept of convergence should be advanced, open, and innovative. Today,

the rapid development of technologies such as big data, cloud computing, QR code recognition, and virtual reality is driving a new round of content ecosystem reconstruction, accelerating the upgrading of content, carriers, and user services. Content has become more diversified, with new forms such as short videos and online education emerging, allowing one type of content to have multiple extension models. Communication carriers have gradually extended from PC to mobile terminals, facilitating anytime, anywhere information dissemination and access. In user services, content disseminators place greater emphasis on connections with users, as big data makes it possible to mine user preferences and provide targeted content services for precise user needs, representing a vast market space. However, due to technological limitations, traditional publishing still struggles to break through technical barriers and achieve integrated development, despite the flourishing channels and broad market space.

1.3 Lack of User Data and Inaccurate Content Delivery

Under the traditional publishing model, publishing units and users have long been disconnected, with no channels to obtain user preferences and needs. User data flows to third-party book sales platforms such as JD.com and Dangdang. Without access to user needs, precise content cannot be delivered to target users. Although some publishing units have launched knowledge services, the lack of data support results in low delivery efficiency, unclear targeting, and largely formalistic services, causing substantial high-quality content resources to be wasted.

1.4 Disconnected Integration Processes and Weak Talent Quality

In recent years, numerous publishing units have embarked on digitalization initiatives. However, digital publishing remains disconnected from traditional publishing, with low cohesion between digital content and traditional paper book content, and integrated business processes largely decoupled from traditional workflows. Many publishing units have invested substantial human, material, and financial resources in developing integrated businesses, only to see them idle due to poor operations, weak resource integration capabilities, and unfavorable platform-business alignment. Some publishers have attempted to develop VR and AR technologies based on paper books, but the enormous costs and market feedback have shown that profits cannot cover investments. Under such business models, traditional editors remain unable to engage with technology or face the market directly, constrained by traditional publishing thinking, lacking innovation capability, and operating with low efficiency.

2.1 The RAYS System and Its Features

The RAYS system is a publishing convergence big data platform developed by Wuhan Ligong Digital Communication Company, a co-builder of the Publishing Convergence Development (Wuhan) Key Laboratory of the National Press and Publication Administration. On the front end, it manifests as intelligent QR

codes printed on paper books, matching precise internet-based online resources and services with paper book content through these codes. On the back end, it is an integrated operation platform combining content production, integration, management, distribution, and big data collection, constructing a content ecosystem chain with authors, editors, and publishing units at the core and third-party content production institutions as supplements. After readers scan the intelligent QR codes on paper books, the RAYS system can rapidly capture reader behavior data, analyze reader preferences, adopt a reader-oriented approach to meet personalized needs of different readers, achieve two-way interaction between content producers and readers, provide more precise and in-depth knowledge services based on traditional paper books, and form new consumption models.

2.2 The Technical Innovation Model of the RAYS System

Through the integration of knowledge resources, the RAYS system constructs an online-offline integrated knowledge service system, tightly aligning the limited content resources of traditional paper books with diversified online content and services, enabling traditional books to connect with the vast resources of the internet. Through precise push of knowledge services, it can accurately depict user behavior tags based on reading time, content, and behavior, and continuously deliver precise content to users according to these tags, achieving value fulfillment through precise content for users. Simultaneously, through platform construction, it opens up the entire process of content production, organization, processing, and consumption, enabling authors, editors, and internet-based third-party content production institutions to collaboratively produce and organize content on the platform, allowing each role to perform its own functions, and ultimately delivering high-quality content to users. The core technologies employed by RAYS include:

Massive Heterogeneous Knowledge Resource Fusion Technology. This technology effectively addresses the low organizational efficiency of massive knowledge resources in the publishing industry. At the resource layer, RAYS has designed a unified knowledge resource description model based on knowledge graphs for the publishing domain, as well as an HDFS high-expansion storage solution for heterogeneous resource files based on elastic storage. This enables efficient storage, dynamic updating, and rapid retrieval of massive heterogeneous knowledge resources based on a distributed hybrid cloud architecture, providing robust support for multi-format rich media applications on mobile internet. At the knowledge layer, through automatic construction of multi-granularity knowledge tag systems and semi-automatic annotation of knowledge resources, it forms a unified knowledge base and complete knowledge system, capable of providing diverse and multi-level knowledge services to users based on fragmented knowledge such as knowledge units and knowledge points.

Precision Push Technology for Knowledge Services Based on Spatiotemporal Big Data. This technology specifically addresses the problem

that existing recommendation technologies fail to meet the personalized knowledge service demands matched with mobile internet spatiotemporal scenarios. RAYS conducts fusion analysis based on user spatiotemporal behavior big data, predicts user interests and their evolution based on hypernetworks, constructs a four-dimensional interest graph of "user-time-space-interest," accurately obtains user portraits, and designs an interest-tag hybrid recommendation algorithm based on spatiotemporal scenario matching, significantly improving recommendation accuracy. For example, on the RAYS platform's reader data page, editors can see that a female reader named "LUSISA" from Wuhan, aged 28-31, scans into a primary school third-grade English supplementary book from Changjiang Children's Publishing House every Tuesday and Friday between 16:00 and 20:00. The system shows that her average score on online "standard score" English exercises is around 85 points. Additionally, the system indicates she browsed the sales page for a primary school third-grade English vocabulary 辅导 book for nearly 8 minutes. From this, we can infer that the user is likely a mother of a primary school third-grade child, focusing on tutoring her child in English at fixed weekly times. Meanwhile, she is interested in other methods to improve her child' s English performance. The system automatically tags this user with keywords such as "primary school third grade," "English," "ability improvement," and "supplementary teaching materials," and promotes precise products and services she may need from the content library, such as supplementary exercise books and online English courses. Based on this user' s related needs, the system can also proactively push content such as primary school third-grade mathematics and Chinese language tutoring to the user.

Semantic-Based Multi-Granularity Fusion Technology for Knowledge Service Resources. To meet users' multi-granularity knowledge needs, the RAYS platform researches knowledge service resource multi-granularity fusion technology oriented toward a unified knowledge service resource library, designs a knowledge service resource granularity space model and filling algorithm, and constructs a semantically associated granularity world. It establishes enterprise standards for document splitting technology and annotation technology, and performs "fragmentation" processing on coarse-granularity knowledge service resources (books, journals, test questions, etc.) based on resource attribute information (ISBN, language, author, resource type, publication date, publisher, subject terms, etc.) and catalog information. For fragmented knowledge service resources, it researches semantic-based multi-granularity concept fusion technology, establishes a hierarchical structure for knowledge service resources, making them orderly and structured. On this basis, it develops automatic indexing tools for knowledge service resources, achieving indexing operations for all resource attributes such as knowledge attributes, difficulty attributes, and question type attributes, establishing a standardized knowledge service resource tag system that facilitates resource retrieval and secondary use, improving the speed and accuracy of pushing and customizing knowledge service resources. It further considers the impact of knowledge incremental updates on the number of knowledge granules, designing a similarity-based knowledge granule incremen-

tal update mechanism to construct a dynamically updated multi-granularity knowledge base.

Large-Scale Customization Technology for Knowledge Service Chains Oriented to Multiple Roles. The problem of disconnected business processes throughout the publishing industry chain is widespread. Based on modularization and standardization of knowledge services, the RAYS system constructs a deep knowledge service chain containing multiple modules such as knowledge resource organization, processing, and consumption. Through intelligent matching of knowledge resources oriented to personalized user needs, it opens up both supply and demand ends, extends modern paper books or digital content products to internet knowledge services, achieves personalized knowledge resource supply, processing, and consumption, and forms a knowledge service ecosystem including authors, editors, publishers, and readers.

Currently, the RAYS system has provided services for public announcement supplementary teaching materials in 17 provinces and over 35% of 辅导教材教辅 nationwide. It covers 44 of the 49 professional qualification examination subjects stipulated by the Ministry of Human Resources and Social Security, opening up two-way entrances between traditional publishing and online education, integrating online and offline educational resources. Using online derivative knowledge services from supplementary teaching materials and reference books, it effectively expands the coverage of high-quality educational resources, enabling children in remote areas to access more equitable, efficient, high-quality, and convenient knowledge services, which has positive significance for promoting educational informatization and equity.

3.4 Enhancing the Dissemination Power and Guidance Power of News Publishing

The RAYS system utilizes big data technology to integrate multimedia, multi-channel, multi-platform, and multi-format data resources, constructing a unified resource center. On this foundation, it builds a unified knowledge service platform connecting supply and demand ends, reconstructing the knowledge service ecological relationships among authors, editors, operators, publishers, and readers. It reconstructs the integration ecosystem between the news publishing industry and third-party content industries such as online education and audio platforms, as well as external industries, providing readers with deep and comprehensive knowledge services that powerfully enhance the market competitiveness of traditional publishing. It completes "ideal user profiling" from both demand and supply sides, achieving effective scheduling of knowledge resources. It helps traditional editors transform from content proofreaders to knowledge service providers and helps traditional publishing units transform from content product manufacturers to knowledge service suppliers, innovating content production and services, expanding content dissemination channels, broadening profit channels, and increasing revenue and profits. It assists the publishing industry in constructing a brand-new publishing convergence ecosystem, creates

a digital content profit model with content providers as the primary commercial value, changes the ways readers acquire and disseminate knowledge, and leads the direction of China' s news publishing internet+ transformation, convergence upgrading, and industrial development.

3.5 Elevating the Overall Level of Industry Talent

In the process of transforming publishing units through convergence, RAYS emphasizes mobilizing the power of core content producers—editors. For editors' content production and management interfaces, RAYS adopts a light-technology, light-operation approach in a manner more acceptable to traditional editors, mobilizing their enthusiasm for content production and gradually training their technical application capabilities, marketing awareness, user awareness, and internet innovation thinking. Currently, RAYS has cumulatively trained a substantial number of editors, promoting their transformation from traditional editors to knowledge service providers.

3.2 Assisting Supply-Side Reform in the News Publishing Industry

Since the "supply-side reform" was first proposed in 2015, it has become the core of China' s current economic work. The publishing industry similarly faces problems such as "supply-demand mismatch,""severe content homogenization,""excess inventory," and "resource waste," which also reflect issues such as weak planning capabilities, poor market awareness, insufficient innovation consciousness, single distribution channels, and backward service methods in publishing units. Using paper books, newspapers, and periodicals as the medium, the RAYS system matches high-quality, multi-form knowledge resources with audience needs, forming a "content+" based digital content industry convergence system. It expands high-quality information consumption supply from the supply side, broadening the depth, breadth, and coverage of knowledge service supply. It promotes deep integration of traditional publishing in content, channels, platforms, operations, and management, achieving mutual integration and connectivity of knowledge services among authors, editors, publishers, and readers. Simultaneously, through technology and operations, RAYS effectively stimulates innovation consciousness, technical awareness, market awareness, and internet consciousness in publishing units and editors, injecting momentum for future development.

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Note: Figure translations are in progress. See original paper for figures.