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Adoption of AI Scoring Systems in Wushu Competitions: A Theoretical Configuration Analysis Based on the TOE Framework

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Abstract

The integration of Artificial Intelligence (AI) scoring systems represents a pivotal innovation for the digital transformation of Wushu competitions. Moving beyond technical feasibility studies, this theoretical article addresses the critical organizational-level question of adoption. It employs the Technology-Organization-Environment (TOE) framework as a foundational lens to systematically analyze the complex, conjunctural causal mechanisms influencing the adoption decisions of Wushu event organizations. The article conceptualizes a set of seven key conditions within the TOE dimensions: technological complexity and compatibility; organizational readiness and top-management support; and competitive pressure, policy support, and public expectations. It posits that high adoption intention is not determined by any single factor but emerges from specific configurations of these conditions. The analysis proposes three distinct, equifinal theoretical pathways to adoption: the Technology-Leading path, the Competition-Driven path, and the Environment-Pulled path. Conversely, it identifies the combination of high technological complexity and a lack of top-management support as a core theoretical barrier. This configurational perspective challenges linear adoption models and provides a nuanced theoretical foundation for developing differentiated strategies to facilitate the modernization of Wushu, balancing technological advancement with the sport's unique cultural essence.

Keywords

AI Scoring Systems; Wushu Competitions; Technology Adoption; TOE Framework; Configuration Theory; Digital Transformation

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1 Introduction

The global sporting landscape is undergoing a profound digital revolution, with AI and computer vision technologies increasingly deployed to enhance judging objectivity, operational efficiency, and viewer engagement[1]. International federations for gymnastics, taekwondo, and diving have pioneered the use of AI-assisted scoring systems[2]. Within this context, the International Wushu Federation's (IWUF) explicit mandate to explore AI for judging presents a significant impetus for modernizing Wushu, a sport deeply rooted in Chinese cultural tradition. However, the adoption of AI scoring in Wushu transcends a mere technological upgrade; it constitutes a systemic shift impacting established judging practices, organizational processes, and the very interpretation of technical and artistic performance.

Despite its potential to mitigate human error and increase transparency, the adoption rate of AI scoring among Wushu event organizations remains uneven. Existing scholarship has predominantly focused on overcoming technical hurdles—such as developing robust action recognition algorithms for complex Wushu movements—while largely neglecting the organizational and contextual determinants of adoption. Models like the Technology Acceptance Model (TAM), which focus on individual perceptions, are insufficient to explain the multi-faceted, strategic decisions made at an organizational leve[3] .This theoretical gap is critical, as understanding why some organizations embrace innovation while others resist is key to successful, sustainable implementation.

To address this, the present article conducts a theoretical analysis grounded in the Technology-Organization-Environment (TOE) framework. It aims to theorize the complex causal interplay that drives Wushu organizations' intentions to adopt AI scoring systems. The central research question is: what configurations of technological, organizational, and environmental conditions theoretically combine to lead to a high intention to adopt AI scoring systems in Wushu competitions? By exploring this question, the article seeks to provide a coherent theoretical model that can guide future empirical research and inform strategic decision-making for stakeholders in Wushu's digital transition.

2 Literature Review and Theoretical Framework

2.1 The Digital Imperative and Unique Challenge of Wushu Scoring

Wushu scoring, particularly for Taolu (routines), is inherently complex and subjective. Judges must holistically assess "action quality, power, coordination, spirit, rhythm, and composition," with criteria like "spirit and expression" (jingshen) relying heavily on experiential interpretation. This subjectivity, while central to the art, can lead to perceived inconsistencies. Digitalization efforts began with video replay but are now advancing toward AI systems using 3D motion capture and pose estimation to compare performances against benchmarked movement libraries.

The core technical challenge lies in quantifying the qualitative—capturing the fluidity of Tai Chi, the explosive power of Changquan, or the synergistic "jing, qi, shen" (essence, energy, spirit) of a performance. While AI shows promise in assessing objective metrics (e.g., completion of prescribed difficulty, balance),

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its capacity to evaluate stylistic and expressive nuances remains a subject of debate. This creates a fundamental tension between the pursuit of "objective" scoring and the preservation of Wushu's cultural esthetics, directly influencing an organization's perceived usefulness and ease of use of the technology.

2.2 The TOE Framework: A Lens for Organizational Innovation

The TOE framework, developed by Tornatzky and Fleischer, provides a robust, multi-level structure for analyzing technological innovation adoption within organizations. It posits that three interrelated contexts shape the process[4]:

Technological Context: Encompasses both the internal and external technologies relevant to the organization, including their perceived advantages, compatibility with existing systems, and complexity.

Organizational Context: Refers to the characteristics and resources of the organization, such as its size, managerial structure, human capital (including technological readiness), and the degree of top-management support for innovation.

Environmental Context: Represents the arena in which the organization operates, including industry characteristics, competitive pressure, the regulatory landscape, and relationships with government bodies and the public.

The TOF framework's strength lies in its comprehensiveness and situational flexibility. It has been successfully applied to study adoption in e-commerce, e-government, and healthcare informatics. In sports, it has been used to analyze the adoption of data analytics by professional clubs. This article argues that the TOE framework is uniquely suited to theorize adoption within Wushu organizations—entities that operate at the intersection of cultural heritage preservation and modern sports management.

2.3 Developing an Integrated Theoretical Configuration Model

Building upon the TOE framework and the specificities of Wushu, this article proposes an integrated configurational model centered on seven constitutive conditions:

Technological Dimension:

Technological Complexity: The degree to which an AI scoring system is perceived as difficult to understand, implement, integrate, and operate within the specific, varied context of Wushu competitions.

Technological Compatibility: The extent to which the AI system is perceived as aligning with existing competition workflows, data systems, and, crucially, the prevailing judging culture and practices.

Organizational Dimension:

Organizational Technological Readiness: The organization's level of tangible IT infrastructure (e.g., high-speed networking, processing hardware) and intangible knowledge resources (e.g., in-house technical expertise, prior experience with digital projects).

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Top-Management Support: The active commitment, championing, and resource allocation from senior leaders and decision-makers within the Wushu organization, which is vital for legitimizing and funding the innovation.

Environmental Dimension:

Competitive Pressure: The force exerted by rival or peer events that have adopted technological enhancements, raising the stakes for maintaining legitimacy, audience share, and reputational advantage regarding fairness and modernity.

Policy Support: The presence of favorable directives, funding schemes, pilot programs, or regulatory guidelines from authoritative bodies like national sports administrations or Wushu federations that encourage or mandate technological innovation.

Public Expectations: The demand from spectators, media, and the broader Wushu community for greater transparency, consistency, and technological sophistication in event presentation, often amplified following high-profile judging controversies.

The core theoretical proposition is that a high intention to adopt AI scoring systems is not a function of isolated conditions but is best explained by specific, synergistic configurations of conditions across the TOE dimensions. Furthermore, multiple distinct configurations may lead to the same outcome—a concept known as equifinality.

3 Theoretical Pathways to Adoption: A Configurational Proposition

Based on logical inference from the TOE model and the nature of Wushu organizations, this article theorizes three primary conjunctural pathways that could lead to high adoption intention.

3.1 Pathway 1: The Technology-Leading Configuration

This path is characterized by the conjunction of high technological compatibility, strong organizational readiness, and clear policy support. Here, adoption is driven primarily by internal technological capability and favorable alignment. The organization possesses the infrastructure and skills to assimilate the new technology, which is seen as a logical extension of its current digital ecosystem. Strong external policy support (e.g., being designated a pilot site) provides the final catalyst and reduces perceived risk. This pathway is theoretically most likely for well-resourced, technologically proactive organizations, such as national federations or major commercial event operators with established digital strategies.

3.2 Pathway 2: The Competition-Driven Configuration

This path is defined by the combination of intense competitive pressure, strong top-management support, and the absence of high technological complexity (i.e., the system is perceived as relatively straightforward to deploy). In this scenario, the primary driver is external market threat. To gain a competitive edge in terms of credibility or spectacle, management actively seeks a technological solution. The adoption is feasible

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because the chosen system is perceived as modular, user-friendly, or offered as a turnkey solution, thereby circumventing the major barrier of complexity. This pathway typifies the theoretical logic of commercially-oriented Wushu promotions operating in a saturated market.

3.3 Pathway 3: The Environment-Pulled Configuration

This path arises from the confluence of strong policy support, high public expectations, and a baseline of organizational readiness. The driving force is a powerful external pull from the institutional and social environment. The organization, which may have moderate internal drive, is compelled to adopt to align with governmental or federational priorities and to respond to societal demands for modernization and fairness, often following a crisis of legitimacy. This pathway is theoretically relevant for public-facing or government-linked Wushu bodies for whom social license and institutional alignment are paramount.

3.4 The Core Barrier Configuration

Theoretical analysis also suggests a potent barrier configuration: high technological complexity coupled with a lack of top-management support. Regardless of other potentially favorable conditions, this combination is theorized to significantly stifle adoption intention. It highlights that perceived obstacles are not merely additive but interact synergistically to create a formidable blockade.

4 Discussion and Theoretical Implications

4.1 Advancing the TOE Framework in Sports and Cultural Contexts

This article demonstrates the utility of the TOE framework for analyzing technological adoption in the unique niche of traditional sport. It expands the framework's conceptual boundaries by emphasizing that compatibility in Wushu must account for socio-technical integration with deep-seated judging traditions and cultural values. The configurational approach moves beyond identifying net effects of variables to theorizing how their interdependencies create unique causal recipes for adoption.

4.2 The Principle of Equifinality and Strategic Implications

The proposition of three equifinal pathways underscores that there is no single "best way" to foster adoption. Different types of Wushu organizations (e.g., commercial vs. administrative, elite vs. grassroots) are theorized to follow different logics based on their distinctive resource profiles and environmental pressures. This has direct strategic implications: a one-size-fits-all promotion strategy for AI scoring is likely to fail. Effective interventions must be tailored, targeting the specific condition configuration relevant to the target organization.

4.3 Reconceptualizing Barriers: Asymmetry and Causality

The configurational model allows for asymmetric causation. For instance, while the absence of complexity can be part of a successful adoption path (Pathway 2), the presence of complexity alone does not necessarily drive adoption but becomes critically inhibitive when combined with a lack of leadership support.

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This nuanced view helps pinpoint where interventions (e.g., simplifying system interfaces, demonstrating ease of use to management) can be most effectively targeted to break specific logics of resistance.

5 Conclusion

This theoretical article has constructed a configurational model to explain the adoption of AI scoring systems in Wushu competitions. By applying and extending the TOE framework, it has conceptualized a set of seven key conditions and theorized how their interplay leads to adoption intention through three distinct pathways: Technology-Leading, Competition-Driven, and Environment-Pulled. It also identified a core barrier configuration. The analysis affirms that the journey toward digital judging in Wushu is a multi-faceted organizational challenge, not merely a technical one.

The proposed model serves as a foundation for future empirical research, such as Qualitative Comparative Analysis (QCA) studies, to test and refine these theoretical propositions. For practitioners, it offers a diagnostic tool to assess organizational posture and a rationale for developing nuanced, context-sensitive strategies to guide Wushu's evolution. Ultimately, the successful integration of AI in Wushu hinges on thoughtfully navigating the confluence of technology, organization, and environment, ensuring that innovation enhances rather than undermines the rich cultural tapestry of the sport.

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