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# THE USAGE OF WEARABLE TECHNOLOGY FOR MODERN AND LEARNING SOCIETIES: A STRUCTURAL EQUATION MODELING APPROACH IN WENZHOU, CHINA

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## Abstract

This mixed-method research aims to study the key success factors of the wearable device industry in Wenzhou, analyze and apply the possible key success factors and the structural equation modeling of the wearable device industry in Wenzhou, China. The research instruments are questionnaire for quantitative part, and in-depth interview form for qualitative part. Data collecting from 400 respondents and 6 CEOs and executives of leading wearable technology companies in Wenzhou. The results reveal that the integration of wearable technology in modern and learning societies has transformed to digital environments, education, healthcare, and smart city ecosystems. The model identifies three primary independent variables: technological factors (TF), market-related factors (MF), and socio-cultural factors (SF), which contribute to key success factors (KSF) in

wearable technology adoption. The SEM equation, **KSF = 0.324*TF* + *0.547*MF + 0.572*SF; $R^2$ = 0.794**, confirms that socio-cultural influences play the most significant role, followed by market-related and technological factors. These findings suggest that understanding consumer preferences, branding strategies, and product differentiation is critical for the widespread adoption and sustained success of wearable devices in China's evolving digital landscape. The qualitative insights gathered from six CEOs and executives of leading wearable technology companies in Wenzhou reinforce these quantitative findings that are the demand for health-tracking features integrated with AI and real-time monitoring to support China's smart city initiatives, to improve battery life and seamless IoT connectivity, in enhancing user experience, to distribute networks in expanding into tier-2 and tier-3 cities, and integrating wearable healthcare applications with medical monitoring systems to support China's aging population and those with chronic illnesses. The study's findings highlight the growing role of wearable technology in modern societies, particularly in education, healthcare, and smart city applications. In learning societies, wearable devices enhance interactive education by enabling real-time progress tracking, biometric feedback, and AI-driven personalized learning experiences. The smart city framework benefits from wearables through contactless payment systems, mobility tracking, and safety enhancements. Therefore, the research results help to create a modern learning society by using wearable technology.

**Keywords:** Wearable Technology; Learning Society; Structural Equation Modeling; Smart Cities; Socio-Cultural Influences

# Introduction

Technological advancements since the late 20th and early 21st centuries have significantly driven globalization, fostering interconnectedness and interdependence across the world. These advancements have fueled economic growth, improved incomes and living standards (Aslam et al., 2018). The rise of information technology, particularly the internet, has revolutionized communication and data exchange, allowing vast amounts of data to be

transmitted globally every second (McKinsey & Company, 2016). One of the most notable innovations emerging from this technological evolution is wearable computing. Wearable devices, such as smartwatches, fitness trackers, and augmented reality glasses, have become increasingly integrated into daily life, offering enhanced functionalities across industries, including healthcare, manufacturing, sports, and banking (Choi et al., 2017). These devices not only improve convenience but also provide real-time data collection, enabling users to monitor health, productivity, and engagement in digital and learning environments.

The wearable device industry has experienced exponential growth since 2012, with global shipments reaching 171 million units that year (IMS Research, 2013). By 2018, annual shipments had surged to 485 million, reflecting the increasing integration of wearable technology into daily life (Melanson & Gorman, 2012). Projections indicate that the market will grow at a compound annual growth rate (CAGR) of 18.0%, reaching USD 265.4 billion by 2026, with a notable surge of 41.51% from 2021 to 2022 (MarketsandMarkets, 2021). China has become a dominant player in the global wearable technology sector, with substantial growth in both volume and value. In China, wearable device shipments increased from 9.4 million units in 2015 to 120.5 million units in 2020, while revenue rose from CNY 16.84 billion (USD 2.62 billion) to CNY 58.25 billion (USD 9.0 billion) during the same period (Statista, 2021). This rapid expansion highlights China's pivotal role in shaping the future of wearable technology, driven by continuous innovation and evolving consumer demand. Furthermore, the wearable technology helps people nowadays to have their daily life with different types of wearable devices as shown in Figure 1:-

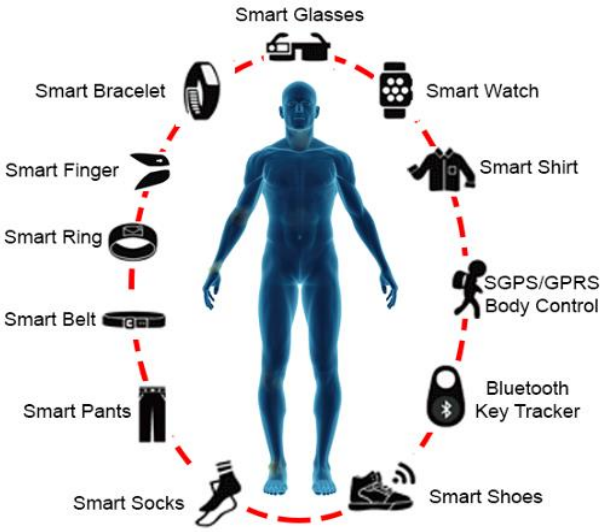


**Figure 1:** Different types of wearable devices (Rodrigues, et al, 2018)

Despite this impressive growth, the wearable device industry faces several challenges, including intense competition, data privacy concerns, regulatory compliance, and the need for cultural alignment in product design. Additionally, companies must navigate complex market dynamics, supply chain disruptions, and sustainability challenges to ensure long-term success. This study seeks to identify the key success factors of the wearable device industry in Wenzhou, China, and analyze their interrelationships using Structural Equation Modeling (SEM). Understanding these factors is crucial for companies looking to enhance their competitive positioning and sustain growth in an evolving digital economy. With technological advancements shaping modern societies into highly interconnected ecosystems, wearable devices have become key drivers of digital transformation and learning societies. These technologies improve user experiences, facilitate personalized learning, and monitor health, making them indispensable in modern life. By applying SEM, this study explores the technological, market-related, and socio-cultural influences that contribute to the widespread adoption and success of wearable devices in both digital and learning societies.

## Research Objectives

1. To study the key success factors of the wearable device industry in Wenzhou, China.
2. To analyze the possible key success factors and the structural equation modeling of the wearable device industry in Wenzhou, China.
3. To apply the results for leveraging wearable technology for modern and learning society societies in Wenzhou, China.

## Literature Reviews

Wearable technology has become a transformative tool in various sectors, particularly in education, smart cities, and digital learning societies. The integration of smartwatches, augmented reality glasses, fitness trackers, and biometric wearables has enhanced personalized learning, student engagement, and data-driven educational experiences (Zhu, 2019; Jiang et al., 2023). Research indicates that wearables in education facilitate real-time feedback, progress tracking, and adaptive learning, aligning with China's Education Modernization 2035 policy. Kornmai (2018) found that perceived usefulness, ease of use, and social influence are key factors driving wearable adoption, while Binyamin & Hoque (2020) emphasized performance expectancy and hedonic motivation as critical in education and health applications. Structural Equation Modeling (SEM) has been widely used to assess technology adoption patterns, helping researchers understand latent factors influencing user engagement and long-term adoption (Yang et al., 2022; Rubin & Ophoff, 2018).

The role of wearable technology in smart cities has also been explored, particularly in areas such as urban mobility, digital governance, and connected health (Kim et al., 2020; Kao et al., 2019). Wenzhou's modernization efforts present opportunities for wearable devices to enhance education, healthcare, and environmental monitoring. Studies on IoT-based fitness wearables highlight the importance of real-time monitoring, AI-driven analytics, and seamless data integration in smart city environments (Kao et al., 2019; Vijayan et al., 2021). However, concerns over data privacy, cybersecurity, and regulatory compliance remain barriers to widespread adoption (Sagmanli, 2022). Research by Rubin &

Ophoff (2018) and Afrouz & Wahl (2019) also emphasizes that habit formation, product aesthetics, and cultural acceptance play crucial roles in shaping long-term wearable usage. These insights highlight the need for customized solutions that align with smart city policies and user expectations in Wenzhou.

While existing studies focus on technological, market, and socio-cultural factors affecting wearable adoption, there is limited research on how these elements interact within the learning society framework. Previous studies analyze consumer expectations, digital trust, and product design, but a comprehensive SEM-based investigation incorporating education, smart city initiatives, and socio-cultural influences in Wenzhou is lacking. This study aims to fill this gap by examining the relationships between technology, market trends, and user behavior using SEM, providing a holistic view of wearable technology adoption in modern learning societies. By integrating these perspectives, this research offers valuable insights for policymakers, educators, and technology developers in enhancing wearable adoption for education, urban planning, and digital transformation in China. Wearable technology is rapidly evolving, influencing education, smart cities, and socio-cultural behaviors. Prior studies confirm that technological advancements, consumer expectations, and digital transformation policies shape wearable adoption. However, the integration of wearable devices into China's learning society requires a deeper analysis of adoption drivers, smart city alignment, and cultural influences.

This study employs Structural Equation Modeling (SEM) to assess key success factors in Wenzhou, addressing critical gaps in wearable adoption research. By combining technology, market trends, and socio-cultural perspectives, this research provides actionable insights for policymakers, educators, and wearable manufacturers in shaping the future of smart education and digital society in China.

## Research Methodology

This study focuses on the wearable technology industry in Wenzhou, China, analyzing its impact on modern learning societies. The research population

consists of stakeholders in the wearable technology sector, including manufacturers, consumers, industry experts, academic institutions, government agencies, and suppliers. To determine the appropriate sample size, the study employs Cochran's formula, ensuring a minimum of 385 respondents to maintain statistical significance. The Taro Yamane formula is used when the population is known, leading to a target sample size of approximately 400 respondents. The study also includes qualitative interviews with executives from three wearable device companies of different sizes—small, medium, and large—to gain in-depth insights into industry trends and challenges. The Study Employs both Quantitative and Qualitative Research Methods:

1) Structured Questionnaires – The primary instrument for collecting quantitative data. The questionnaire includes Likert-scale questions covering technological, market-related, and socio-cultural factors affecting wearable adoption. The Item Objective Congruence (IOC) method is applied to ensure validity, with an acceptable IOC score between 0.80 and 1.00. A pilot test is conducted with 10-30 respondents, refining the questionnaire based on Cronbach's alpha reliability testing (target >0.7). 2) Semi-Structured Interviews – Conducted with industry experts, company executives, and academic professionals, focusing on success factors, barriers, and market trends in wearable technology. 3) Focus Groups – Consumer groups provide qualitative insights into wearable technology perception, challenges, and user preferences. Data is analyzed using PASW and AMOS software, incorporating descriptive statistics, reliability testing, Confirmatory Factor Analysis (CFA), and model fit indicators (GFI, CFI, RMSEA).

## Results

Key Success Factors of Wearable Technology in Wenzhou's Learning Society: The study identifies three primary factors influencing the success of wearable technology adoption:

1. Technological Factors – Innovations in sensor accuracy, battery life, connectivity, and user interface design significantly impact the usability and competitiveness of wearable devices. Battery life (M = 4.53, SD = 0.62) and connectivity (M = 4.62, SD = 0.54) were the most critical components.

2. Market-Related Factors – Elements such as pricing strategy, brand reputation, distribution channels, and market positioning were rated highly in importance. Competitive pricing (M = 4.67, SD = 0.55) and brand reputation (M = 4.56, SD = 0.72) were essential in driving adoption.

3. Socio-Cultural Factors – Cultural preference, social norms, and consumer attitudes significantly influence wearable acceptance. Social conformity (M = 4.13, SD = 0.59) and consumer perceptions of wearable brands (M = 4.08, SD = 0.33) were crucial. The structural equation model (SEM) analysis confirmed that market-related factors (β = 0.547) and socio-cultural factors (β = 0.572) had the highest impact on consumer satisfaction and financial viability, while technological factors (β = 0.324) influenced usability.

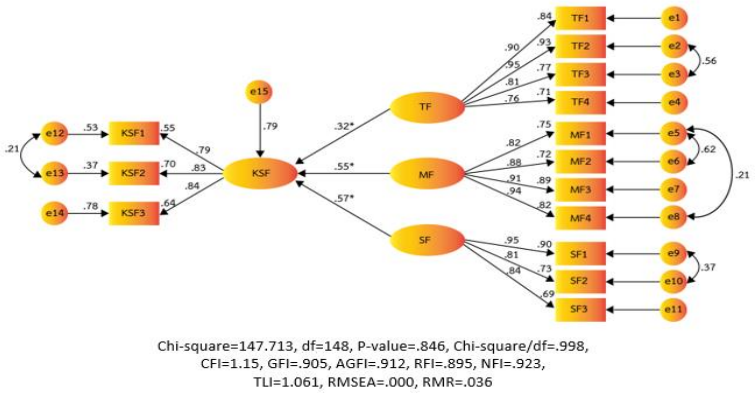


**Figure 2:** Modified structural equation model of factors influencing the success of the wearable device industry in Wenzhou, China**.**

Analysis of the Structural Equation Model (SEM): The SEM model fit assessment confirms that the proposed model is statistically valid, with all model indices meeting required thresholds ($\chi^2$/df = 1.00, CFI = 1.15, RMSEA = 0.00). The result is shown in Table 1.

**Table 1** Model fit index of the after-modifying model

| Index | Criteria | Scores | Results |
|---|---|---|---|
| $\chi^2$/df | <3.00 | 1.00 | Pass |
| CFI | ≥0.95 | 1.15 | Pass |

| | | | |
|---|---|---|---|
| GFI | ≥0.90 | 0.91 | Pass |
| AGFI | ≥0.90 | 0.91 | Pass |
| TLI | ≥0.90 | 1.06 | Pass |
| RMSEA | <0.08 | 0.00 | Pass |
| RMR | <0.80 | 0.04 | Pass |

The results indicate that socio-cultural and market-related factors are the strongest predictors of wearable technology success, explaining 79.4% ($R^2$ = 0.794) of the variance in adoption.

Implementation of the Structural Model and Stakeholder Validation: A stakeholder validation survey with 35 industry professionals (from China Smart Valley and Huawei Wenzhou) confirmed that all key factors were suitable for implementation.

1. Technological Factors: 100% agreement on the importance of battery life and connectivity.
2. Market-Related Factors: 97.1% agreement on the role of distribution channels in expanding wearable adoption.
3. Socio-Cultural Factors: 94.3% agreement on consumer attitudes influencing long-term adoption.

The results of direct and total effects are shown in Table 2.


**Figure 3:** Direct and the total effect of influencing factors.

This study confirms that wearable technology adoption in Wenzhou's learning society is driven by technological advancements, market competitiveness, and socio-cultural influences. The validated SEM model provides a robust framework for understanding these factors, offering actionable

insights for business leaders, policymakers, and technology developers. Future research should explore AI-driven analytics, wearable education platforms, and digital policy frameworks to enhance wearable adoption in smart learning environments.

Additionally, the results shown in Figure 3 can be conducted in the equation form of the structural equation model as follows:

$$KSF = 0.324*TF + 0.547*MF + 0.572*SF;\ R^2 = 0.794.$$

The Structural Equation Model (SEM) illustrates how Technological Factors (TF), Market-Related Factors (MF), and Socio-Cultural Factors (SF) influence Key Success Factors (KSF) in wearable technology adoption for modern learning societies in Wenzhou, China. The equation KSF = 0.324*TF* + *0.547*MF + 0.572*SF indicates that socio-cultural influences (0.572) have the strongest impact, followed by market-related factors (0.547), while technological factors (0.324) play a supportive role. With $R^2 = 0.794$, the model explains 79.4% of the variance in wearable adoption. These findings align with smart cities' digital transformation, emphasizing cultural acceptance, market demand, and technological advancement as critical drivers for success.

## Discussions

Learning Societies—A Structural Equation Modeling Approach in Wenzhou, China," the results can be discussed as the key research objectives. The study identified technological, market-related, and socio-cultural factors as the primary determinants of wearable technology adoption**.** The structural equation model (SEM) equation ($KSF = 0.324TF + 0.547MF + 0.572*SF;\ R^2 = 0.794$) confirms that socio-cultural factors (SF) have the highest influence ($\beta = 0.572$), followed by market-related factors ($\beta = 0.547$) and technological factors ($\beta = 0.324$). These results highlight the importance of social norms, consumer behavior, and market preferences in driving wearable device adoption in Wenzhou's learning society.

Overall, the research findings indicate that the success of wearable devices in modern smart cities and educational environments relies on aligning

technology with consumer expectations, optimizing market positioning, and integrating socio-cultural influences**.** Stakeholders should prioritize product customization, enhance brand reputation, and refine distribution strategies to maximize adoption. Additionally, advancing wearable technology through AI-driven features, improved battery life, and IoT connectivity will enhance usability and long-term engagement. The study confirms that a well-balanced strategy, integrating technological innovation, cultural adaptation, and market dynamics, is essential for the sustainable growth of the wearable device industry in Wenzhou and beyond**.**

## New Knowledges

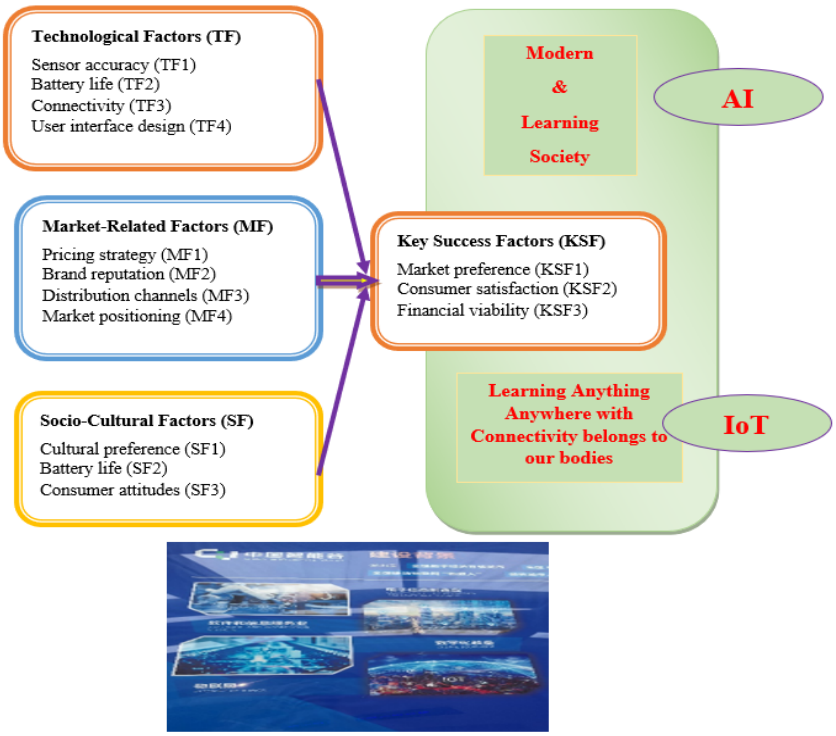


**Figure 4:** Structural Equation Model for Wearable Technology Adoption in Modern Learning Societies.

**Figure 4:** illustrates the key success factors influencing wearable technology adoption in modern learning societies, particularly in Wenzhou, China. It is based on the research's Structural Equation Model (SEM) findings, showing how technological, market-related, and socio-cultural factors impact the success of wearable devices in smart learning environments. The model highlights three primary categories:

1. Technological Factors (TF): This includes sensor accuracy, battery life, connectivity, and user interface design. These factors influence how efficient, reliable, and user-friendly wearable devices are. Connectivity (TF3) and battery life (TF2) play critical roles in ensuring seamless Internet of Things (IoT) integration for uninterrupted learning experiences.

2. Market-Related Factors (MF): This considers pricing strategy, brand reputation, distribution channels, and market positioning. Brand reputation (MF2) and market positioning (MF4) are particularly significant in influencing consumer preferences and financial viability (KSF3), determining how well these technologies penetrate the learning society.

3. Socio-Cultural Factors (SF): This encompasses cultural preferences, battery life, and consumer attitudes. Cultural acceptance (SF1) plays a major role in driving wearable adoption, as consumers in learning societies must perceive wearables as essential educational tools.

These factors collectively impact the Key Success Factors (KSF), including market preference (KSF1), consumer satisfaction (KSF2), and financial viability (KSF3). Integrating AI and IoT enables a seamless learning experience, emphasizing "Learning Anything, Anywhere with Connectivity Belonging to Our Bodies." This research provides insights into how wearable technology enhances smart education, aligns with digital transformation goals, and fosters an interconnected learning society in Wenzhou and beyond.

## Conclusions

The integration of wearable technology in modern and learning societies has transformed to digital environments, education, healthcare, and smart city ecosystems. The model identifies three primary independent variables: technological factors (TF), market-related factors (MF), and socio-cultural factors (SF), which contribute to key success factors (KSF) in wearable technology adoption. These findings suggest that understanding consumer preferences, branding strategies, and product differentiation is critical for the widespread adoption and sustained success of wearable devices in China's evolving digital landscape. The study's findings highlight the growing role of wearable technology in modern societies, particularly in education, healthcare, and smart city applications.

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