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Optimizing Digital Healthcare Distribution: An Integrated Model of Channel Efficiency and Technology Acceptance*

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Abstract

Purpose: Purpose: This study examines the optimization of healthcare service distribution through digital channel adoption by integrating anticipatory governance perspectives with distribution channel frameworks, emphasizing the role of digital service delivery networks. **Research design, data and methodology:** The research employs a mixed-methods approach incorporating qualitative expert interviews and quantitative survey data from 295 users across diverse distribution regions of Vietnam. The conceptual framework analyzes the relationships between distribution service quality, security protocols, perceived distribution benefits, and future perception through Partial Least Squares Structural Equation Modeling, focusing on channel efficiency and service accessibility. **Results:** The findings reveal that service quality and security measures in digital channels significantly influence attitudes toward distribution systems, while traditional usability factors show minimal impact. The study introduces future perception as a novel construct in distribution science, demonstrating its significant effect on adoption intentions. Multi-group analysis reveals notable variations in distribution effectiveness across geographical regions and demographic segments, with distinct patterns between urban and rural areas. **Conclusions:** The research advances distribution theory by demonstrating how anticipatory elements and demographic variations influence digital service delivery optimization. These insights provide strategic implications for developing efficient, segment-specific digital distribution networks in healthcare service delivery.

Keywords: Channel optimization, Digital distribution channels, Distribution innovation, Future perception, Healthcare service networks.

JEL Classification Code: L81; M31, O33

1. Introduction

The advent of digital distribution channels has fundamentally transformed healthcare service delivery, marking a paradigm shift from traditional face-to-face interactions to technology-enabled service networks. Recent evidence demonstrates that digital healthcare distribution channels not only enhance service accessibility but also significantly optimize resource allocation across healthcare networks. Studies by Truong et al. (2022) and Leonard et al.

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(2023) highlight that efficient digital distribution channels can reduce healthcare access disparities while improving service delivery outcomes across diverse geographical regions. However, the optimization of these channels presents complex challenges, particularly in ensuring equitable access and consistent service quality.

The effectiveness of distribution channels varies significantly across demographics and geographical regions, with studies revealing persistent disparities in channel accessibility and utilization (Bustamante et al., 2023; Abdullah et al., 2023). These distribution challenges are compounded by variations in technological infrastructure, security protocols, and user acceptance across different service regions. Research by Fischer et al. (2020) and Müller et al. (2021) emphasizes that the success of digital healthcare distribution networks depends critically on both the quality of distribution technology and the robustness of security measures implemented across service channels.

Contemporary literature reveals significant gaps in understanding the dynamics of digital healthcare distribution networks. While existing research has extensively examined technology adoption in healthcare, limited attention has been paid to the integration of distribution channel frameworks with anticipatory governance perspectives. Recent studies by Jiang et al. (2022) underscore how socioeconomic factors and health literacy significantly influence distribution channel effectiveness, yet the interaction between these factors and future-oriented perspectives in distribution network optimization remains unexplored. Furthermore, the relationship between traditional channel acceptance determinants and anticipatory governance principles requires systematic investigation, particularly within chronic disease management contexts.

This study addresses these critical gaps by developing and empirically validating an integrated model that positions future perception as a key determinant of distribution channel optimization in healthcare service delivery. Through the novel integration of anticipatory governance principles with established distribution channel frameworks, we examine how perceptions of future distribution capabilities influence current channel adoption decisions. Our research makes substantial theoretical and practical contributions to distribution science. Theoretically, it extends existing distribution channel models by incorporating future perception as a crucial determinant. Practically, it addresses the critical need identified by Shah and Badawy (2021) and Joo and Liu (2021) for understanding factors that influence sustained engagement with digital distribution channels.

The remainder of this paper is organized as follows: Section 2 presents the literature review and theoretical framework, followed by research methodology in Section 3. Section 4 details the empirical results, while Section 5 discusses the findings and their implications. Finally, Section 6 concludes the study with recommendations for future research.

2. Literature Review and Theoretical Framework

2.1. Digital Distribution Channel Theory

The evolution of digital distribution channels in healthcare represents a transformative shift in service delivery paradigms, characterized by the integration of advanced technologies and innovative delivery mechanisms. Digital distribution channels encompass comprehensive pathways through which healthcare services and information are delivered electronically to end-users, including telehealth platforms, mobile applications, and integrated service networks. While studies by Andriopoulou et al. (2018) and Qi et al. (2020) emphasize the positive impact of digital channels on healthcare accessibility and service efficiency, contrasting findings from recent research by Bustamante et al. (2023) highlight significant disparities in channel adoption across different socioeconomic groups. These contradictory results suggest that the effectiveness of digital distribution channels may be contingent upon contextual factors that warrant further investigation.

The focus on healthcare distribution channels is particularly critical given their unique characteristics, including time-sensitivity, personalization requirements, and direct impact on patient outcomes. Recent studies by Williams et al. (2023) and Bond (2023) demonstrate that effective digital distribution in healthcare not only improves service accessibility but also significantly impacts treatment adherence and patient outcomes, distinguishing it from other service sectors. The implementation of advanced distribution technologies, particularly software-defined networking (SDN), has shown significant improvements in response times and service delivery efficiency, especially in managing chronic conditions where continuous monitoring is essential.

The complexity of healthcare service distribution networks, involving multiple stakeholders, necessitates sophisticated distribution efficiency models. Research by Mahdavi et al. (2021) proposes comprehensive mathematical models for distribution system reconfiguration, providing frameworks for optimizing resource allocation across digital channels. Furthermore, the effectiveness of these channels is intrinsically linked to service quality dimensions, including reliability, responsiveness, and user satisfaction. Studies by Wang et al. (2022) demonstrate that high-quality service delivery through digital channels significantly influences patient

satisfaction and loyalty, fundamental to sustainable implementation of digital healthcare initiatives. The integration of robust security protocols within these distribution channels has emerged as a critical factor, particularly given the sensitive nature of healthcare data and the need to maintain patient trust across digital service networks.

2.2. Technology Acceptance in Distribution Channels

The acceptance of technology within healthcare distribution channels represents a critical determinant of successful digital service implementation. Research findings on technology acceptance in healthcare distribution present notable contradictions that require careful examination. While AlQudah et al. (2021) and Isernia et al. (2022) found that healthcare professionals' acceptance is primarily driven by perceived usefulness and performance expectations, studies by Wei et al. (2020) suggest that security concerns and trust factors may override utility considerations in certain contexts. These conflicting findings necessitate a more nuanced understanding of technology acceptance factors in healthcare distribution.

The integration of the Unified Theory of Acceptance and Use of Technology (UTAUT) with distribution channel frameworks has enriched understanding of technology adoption in healthcare service delivery. Recent research emphasizes that social influence and facilitating conditions significantly impact users' intentions to adopt digital distribution channels (AlQudah et al., 2021; Rahimi et al., 2018). Notably, the role of organizational support and peer recommendations has proven crucial in shaping healthcare professionals' attitudes toward new distribution technologies, while access to training and technical support significantly influences the perceived ease of use and overall acceptance of digital channels.

Security considerations have emerged as paramount concerns influencing technology acceptance in digital distribution channels. Research by Harris and Rogers (2021) reveals that different user groups exhibit varying levels of comfort and proficiency with digital technologies, necessitating tailored approaches to channel design and implementation. These findings are particularly relevant for healthcare distribution networks, where service delivery must accommodate diverse user populations while maintaining consistent quality and accessibility across all channels. Furthermore, demographic variations in technology acceptance present unique challenges for digital distribution channel implementation, highlighting the need for adaptive strategies that consider user characteristics and preferences. The implementation of robust security protocols across distribution networks has become essential not only for regulatory compliance but also for fostering trust and encouraging sustained engagement with digital service channels, aligning with findings demonstrating the critical role of trust in facilitating technology acceptance across healthcare distribution networks.

2.3. Distribution Network Optimization

The optimization of distribution networks in healthcare service delivery represents a complex challenge in the digital transformation era. Unlike previous studies that focused primarily on technical aspects of distribution optimization (Liu et al., 2019; Sun et al., 2023), our research integrates anticipatory governance perspectives with traditional optimization frameworks to provide a more comprehensive understanding of how future-oriented perceptions influence current distribution network effectiveness. Recent studies demonstrate that disparities in healthcare access persist across different geographical regions, highlighting the need for sophisticated optimization strategies that can enhance service distribution equity while maintaining operational efficiency.

Channel effectiveness in healthcare distribution networks encompasses multiple factors including service quality, resource utilization, and user engagement. Sun et al. (2023) propose a three-stage super-efficiency SBM model for evaluating healthcare service distribution efficiency, providing valuable insights into the intrinsic drivers of channel performance. This analytical approach enables healthcare organizations to identify optimal resource allocation strategies while maintaining high service quality across their distribution networks. Furthermore, research by Kajwang (2022) emphasizes that successful implementation of digital distribution channels requires careful consideration of both technological infrastructure and user capabilities across different service regions.

Regional distribution variations present unique challenges for network optimization, necessitating tailored approaches to service delivery across different geographical contexts. Studies by Truong et al. (2022) and Papalamprakopoulou et al. (2024) reveal significant disparities in channel effectiveness between urban and rural areas, emphasizing the need for adaptive distribution strategies that can accommodate varying levels of technological infrastructure and user readiness. The integration of accessibility considerations into distribution network design has proven essential for ensuring equitable service delivery and maximizing channel utilization across diverse user populations.

2.4. Research Hypotheses Development

Drawing from established theoretical frameworks and recent empirical studies, we develop nine hypotheses

examining the complex relationships influencing digital healthcare distribution optimization. The relationship between perceived benefits and channel attitudes is grounded in both Technology Acceptance Model and Distribution Channel Theory. Recent research consistently demonstrates that when users recognize clear benefits in managing their healthcare needs through digital channels, they develop more positive attitudes toward these distribution systems. Studies by Truong et al. (2022) and Wiest et al. (2024) reveal that perceived benefits significantly enhance user engagement with digital healthcare services, while Leonard et al. (2023) found that perceived advantages directly influence adoption patterns. Therefore:

H1: Perceived benefits of digital distribution channels positively influence attitudes toward these channels.

Service quality and ease of use emerge as critical factors in digital channel acceptance. Recent studies by Bailey et al. (2021) and Catapan et al. (2023) emphasize that high-quality digital services enhance user trust and satisfaction, particularly in healthcare contexts where service reliability is paramount. Similarly, research by Schretzlmaier and Hecker (2022) demonstrates that user-friendly interfaces significantly enhance attitudes toward digital healthcare systems. This leads to:

H2: Ease of use of digital distribution channels positively influence attitudes toward these channels.

H3: Distribution service quality positively influences attitudes toward digital channels.

The importance of security measures in digital healthcare distribution is particularly critical given the sensitive nature of health data. Studies by Jiang et al. (2022) and Filbay et al. (2022) highlight how adequate technical support helps overcome adoption barriers and builds user confidence. Furthermore, recent findings by Zhu et al. (2023) underscore the significant impact of privacy concerns on users' trust and attitudes toward digital distribution channels. Therefore:

H4: Technical support positively influences attitudes toward digital distribution channels.

H5: Security and privacy measures positively influence attitudes toward digital channels.

Building on UTAUT2 and recent findings from Gately et al. (2022), we propose that attitudes serve as a crucial mediating mechanism. This mediation hypothesis extends beyond traditional technology acceptance models by incorporating distribution-specific considerations. Additionally, technological readiness has emerged as a significant moderating factor in digital healthcare adoption:

H6: Attitudes toward digital distribution channels positively influence intention to use these channels.

H7: Users' technological readiness moderates the relationship between attitudes and intention to use digital distribution channels.

Geographic and demographic variations significantly influence distribution channel effectiveness. Recent research by Truong et al. (2022) and Papalamprakopoulou et al. (2024) highlights disparities in channel access and utilization across different populations. The inclusion of future perception as a predictor represents a novel contribution to distribution channel theory. While previous research by Jungwirth and Haluza (2017) and Martin et al. (2022) has examined future orientation in healthcare technology adoption, our study uniquely applies this concept to distribution channel optimization:

H8: There are significant differences in channel effectiveness across geographical regions and demographic segments.

H9: Perception of future channel development positively influences intention to use digital distribution services.

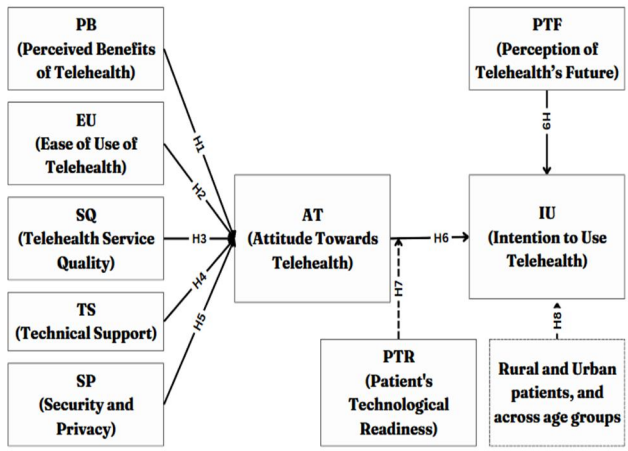

Figure 1: Conceptual Framework

The conceptual framework illustrates the integrated relationships between traditional acceptance factors (H1-H5), mediating mechanisms (H6), moderating effects (H7), and contextual influences (H8) in digital healthcare distribution. The novel incorporation of future perception (H9) represents a unique contribution to distribution channel theory, highlighting how anticipatory governance elements influence current adoption decisions. Solid lines indicate direct relationships, while dashed lines represent moderating effects. This model advances existing frameworks by explicitly considering both present operational factors and future service delivery expectations in healthcare distribution network optimization.

3. Research Methodology

3.1. Research Design

This study employs a mixed-methods approach integrating qualitative expert interviews and quantitative survey methods to ensure robust analysis of healthcare distribution channels. The research process consisted of two sequential phases designed to comprehensively evaluate distribution network effectiveness. The initial qualitative phase involved in-depth interviews with seven healthcare distribution experts and technology specialists to validate and refine the measurement scales, particularly focusing on distribution channel metrics and network performance indicators. This approach aligns with recent methodological recommendations for distribution channel research and scale development procedures (Hair et al., 2021; Thompson et al., 2022).

The subsequent quantitative phase utilized a cross-sectional survey design to test the hypothesized relationships through Partial Least Squares Structural Equation Modeling (PLS-SEM). PLS-SEM was selected over covariance-based SEM (CB-SEM) for several compelling reasons. First, PLS-SEM is particularly suitable for complex predictive models with multiple mediating and moderating relationships (Hair et al., 2021). Second, it effectively handles non-normal data distributions common in healthcare distribution research. Third, PLS-SEM's capability to analyze both reflective and formative measurement models aligns with our research framework. Recent studies by Gately et al. (2022) and Jiang et al. (2022) have successfully employed PLS-SEM in analyzing healthcare distribution networks, confirming its appropriateness for examining multiple mediating and moderating relationships in healthcare distribution contexts.

3.2. Sampling and Data Collection

The target population comprises users of digital healthcare distribution channels who have utilized these services at least once within the past six months, ensuring sufficient experience with digital service networks. The study was conducted across major geographical regions in Vietnam, encompassing both urban metropolitan areas (58%) and rural districts (42%). The urban sample was collected from three strategically selected cities representing different regions of Vietnam: Hanoi (25%) in the North, Da Nang (20%) in the Central region, and Ho Chi Minh City (13%) in the South. This geographic distribution ensures comprehensive representation of Vietnam's diverse healthcare delivery environments and socioeconomic contexts.

Following sampling procedures established in recent distribution research by Mitchell et al. (2023), we employed a stratified random sampling approach through collaboration with healthcare providers across these regions to identify eligible participants. Initial screening ensured that participants met the inclusion criteria regarding recent channel usage and basic technological literacy. The recruitment process utilized a combination of healthcare provider referrals and patient database sampling to minimize selection bias and ensure comprehensive channel coverage.

The final sample consisted of 295 participants, meeting the minimum sample size requirements for PLS-SEM analysis as recommended by Hair et al. (2021). The urban sample (n=171) primarily came from metropolitan healthcare centers, while the rural sample (n=124) was collected from community health facilities in the surrounding areas of the three major cities. The participants represented six major categories of healthcare service users: primary care (28%), specialist care (25%), chronic condition management (15%), emergency services (12%), preventive care (11%), and follow-up services (9%). This distribution aligns with typical healthcare service utilization patterns in Vietnam and ensures adequate representation of various service delivery needs across distribution networks.

Data collection was conducted over a three-month period from August to October 2024, following a systematic sampling protocol. Healthcare providers in Hanoi, Da Nang, and Ho Chi Minh City facilitated participant recruitment through their patient databases, ensuring representative sampling across different service areas. The research team maintained consistent data collection procedures across all geographical locations to ensure data quality and comparability. To ensure data quality, we implemented rigorous quality control measures across all geographic locations. Response patterns were monitored for consistency, and twenty-three incomplete responses were excluded from the final analysis. Additionally, the geographic distribution of responses was regularly monitored to maintain balanced representation across regions, resulting in proportional representation from each major city and their surrounding rural areas. This systematic approach to data collection and quality control helped maintain the integrity and reliability of the research data.

3.3. Measurement Development

The study utilized both established scales and newly developed measures to assess distribution channel effectiveness. The established scales were adapted from prior research and modified to reflect the distribution channel context. Following recent methodological guidelines by Hair et al. (2021) and Thompson et al. (2022),

all adapted scales underwent rigorous validation to ensure contextual appropriateness.

A significant contribution of this study is the development of the Future Distribution Perception (FDP) scale. The scale development process followed a systematic multi-stage approach:

Stage 1: Initial item generation based on comprehensive literature review and expert interviews. Eight potential measurement items were identified, encompassing various aspects of future-oriented perceptions in digital healthcare distribution.

Stage 2: Expert panel review involving seven specialists in healthcare distribution and technology innovation. Through this rigorous consultation process, five key measurement items were retained based on their theoretical relevance and practical applicability.

Stage 3: Content validity assessment using the Content Validity Index (CVI). All retained items achieved CVI scores above 0.80, exceeding recommended thresholds for scale development.

Stage 4: Pilot testing with 30 distribution channel users to confirm scale clarity and comprehensibility.

Table 1: Measurement Scales and Operational Definitions

Construct and Definition	Code	Scale Items	Factor Loading	Reflective Outer Models	Source
Distribution Service Quality (SQ) Definition: The overall quality and reliability of healthcare service delivery through digital distribution channels	SQ1	The digital distribution system provides accurate and reliable healthcare information	0.762	Cronbach's α = 0.774 Composite Reliability:0.774 AVE: 0.596	Kamal et al. (2020)
	SQ2	The digital distribution network is stable and dependable	0.786		
	SQ3	Healthcare staff in digital channels demonstrate good professional knowledge	0.778		
	SQ4	The digital distribution system provides timely responses	0.761		
Distribution Network Accessibility (EU) Definition: The degree of ease in accessing and using digital healthcare distribution channels	EU1	The digital distribution channel is easy to access and navigate	0.711	Cronbach's α = 0.766 Composite Reliability:0.879 AVE: 0.574	Davis (1989); Adapted from Venkatesh et al. (2012)
	EU2	Interactions with the digital distribution system are clear	0.744		
	EU3	The distribution channel is flexible to use	0.704		
	EU4	Overall, the digital distribution system is accessible	0.862		
Distribution Benefits (PB) Definition: Perceived advantages of using digital healthcare distribution channels	PB1	The digital distribution channel enhances healthcare management efficiency	0.772	Cronbach's α = 0.797 Composite Reliability:0.814 AVE: 0.619	Venkatesh et al. (2012)
	PB2	Digital distribution saves time in accessing healthcare services	0.798		
	PB3	The distribution channel improves healthcare accessibility	0.834		
	PB4	Digital distribution enhances healthcare service quality	0.741		
Distribution Security (SP) Definition: Security and privacy measures in digital healthcare distribution	SP1	Personal information is secure in the digital distribution system	0.791	Cronbach's α = 0.779 Composite Reliability:0.782 AVE: 0.599	Kamal et al. (2020)
	SP2	The distribution channel has robust data protection measures	0.774		
	SP3	Information privacy is maintained across distribution channels	0.766		
	SP4	The digital distribution system ensures data confidentiality	0.766		
Channel Attitude (AT) Definition: Overall evaluation of digital healthcare distribution channels	AT1	Using digital distribution channels is beneficial	0.827	Cronbach's α = 0.884 Composite Reliability:0.886 AVE: 0.741	Adapted from Venkatesh et al. (2012)
	AT2	Digital healthcare distribution enhances service experience	0.885		
	AT3	I prefer using digital distribution channels	0.878		
	AT4	Overall, I have a positive view of digital distribution	0.854		
Distribution Usage Intention (IU) Definition: Intention to use digital healthcare distribution channels	IU1	I plan to continue using digital distribution channels	0.767	Cronbach's α = 0.728 Composite Reliability:0.732 AVE: 0.649	Venkatesh et al. (2012)
	IU2	I will actively use digital channels for healthcare services	0.839		
	IU3	I intend to regularly use digital distribution channels	0.808		
Distribution Technical Support (TS) Definition: The level of technical assistance and	TS1	Users have necessary knowledge to use the distribution system	0.821	Cronbach's α = 0.853 Composite Reliability:0.899	Thompson et al. (1991); Adapted from Venkatesh et al. (2012)
	TS2	Clear instructions are available for digital channel usage	0.886		

Construct and Definition	Code	Scale Items	Factor Loading	Reflective Outer Models	Source
infrastructural support available for digital healthcare distribution channels	TS3	Technical assistance is readily available for distribution channel issues	0.851	AVE: 0.684	
	TS4	The organization provides adequate support for digital channel usage	0.742		
Distribution Network Readiness (PTR) Definition: Technical preparedness for using digital distribution channels	PTR1	I am comfortable with new distribution technologies	0.775	Cronbach's α = 0.783 Composite Reliability:0.783 AVE: 0.606	Parasuraman (2000)
	PTR2	I can effectively use digital distribution channels	0.779		
	PTR3	I keep up with digital distribution developments	0.800		
	PTR4	I am confident using digital healthcare channels	0.758		
Future Distribution Perception (PTF) Definition: Perceptions about future development of digital distribution channels	PTF1	Digital distribution will become more prevalent	0.768	Cronbach's α = 0.771 Composite Reliability:0.772 AVE: 0.593	Newly developed
	PTF2	Distribution technology will continue to improve	0.772		
	PTF3	Digital channels will play a larger role in healthcare	0.778		
	PTF4	Distribution networks will integrate advanced technologies	0.761		

Note: All measurement items were adapted to the healthcare distribution context and validated through expert review and pilot testing. The adaptation process ensured contextual relevance while maintaining construct validity.

All constructs demonstrated strong reliability with Cronbach's alpha values ranging from 0.728 to 0.884. Composite reliability values ranged from 0.732 to 0.899, further supporting construct reliability. Individual indicator reliability was established through factor loadings, with all indicators showing satisfactory loadings between 0.704 and 0.886.

Convergent validity was assessed through Average Variance Extracted (AVE) values, with all constructs achieving values above the critical threshold of 0.50. The newly developed PTF scale showed particularly strong psychometric properties, with an AVE of 0.593 and satisfactory reliability measures (Cronbach's α = 0.771, CR = 0.772).

Table 1 presents the complete measurement scales, including construct definitions, items, and psychometric properties. The measurement framework incorporates both traditional distribution channel metrics and innovative measures of future perception, providing a comprehensive assessment tool for evaluating digital healthcare distribution effectiveness.

4. Results

4.1. Descriptive Analysis and Channel Performance

Demographic analysis of the sample reveals a diverse representation of healthcare service users across Vietnam's major regions. The age distribution shows that 35% of participants were between 18-40 years old (n=104), 52% between 41-60 years (n=153), and 13% over 60 years (n=38). Gender distribution indicates 54% female (n=159) and 46% male (n=136) participants. Educational background varies with 42% holding undergraduate degrees, 28% with postgraduate qualifications, and 30% with high school education or below. Income levels were similarly diverse, with 35% in high-income, 45% in middle-income, and 20% in lower-income categories based on Vietnam's socioeconomic standards.

Initial analysis of the distribution channel performance metrics reveals significant patterns in service delivery effectiveness across digital healthcare networks. The descriptive statistics, presented in Table 2, indicate moderate levels of distribution channel performance, with mean values ranging from -0.203 to 0.467 across key distribution metrics. The analysis demonstrates balanced channel utilization patterns, with skewness values ranging from -0.655 to 0.580, suggesting normally distributed channel performance indicators across the healthcare distribution network.

The examination of distribution service quality metrics reveals strong performance in digital channel reliability (mean=0.467) and service responsiveness (mean=0.078), indicating effective service delivery through digital distribution channels. Network accessibility indicators demonstrate moderate effectiveness (mean=-0.050), suggesting opportunities for further optimization of channel accessibility across service regions. Security and privacy measures in distribution channels show consistent implementation (mean=-0.203), though variation exists across different service contexts.

Correlation analysis reveals significant relationships among distribution channel metrics, with service quality showing strong correlation with channel attitude (r=0.620) and future distribution perception demonstrating meaningful associations with both channel attitude (r=0.487) and service quality (r=0.550). All correlations remain below the multicollinearity threshold of 0.8, ranging from 0.219 to 0.714, indicating good discriminant validity among constructs. These relationships highlight the interconnected nature of distribution channel elements while maintaining their distinct measurement properties, providing a solid foundation for analyzing healthcare service distribution through digital channels.

Table 2: Distribution Channel Performance Metrics and Correlations

Panel A: Distribution Performance Statistics

Distribution Metrics	Mean	Excess Kurtosis	Skewness	SD[1]
Distribution Service Quality (SQ)	0.028	-0.889	0.003	0.772
Distribution Network Accessibility (EU)	-0.050	-0.663	-0.008	0.758
Distribution Benefits (PB)	0.078	-0.768	-0.105	0.787
Future Distribution Perception (PTF)	0.079	-0.435	-0.154	0.770
Distribution Security (SP)	-0.203	-0.285	0.580	0.774
Channel Attitude (AT)	0.467	-1.071	-0.655	0.861
Distribution Usage Intention (IU)	-0.019	-0.800	0.046	0.805
Distribution Network Readiness (PTR)	-0.055	-0.713	-0.099	0.778
Distribution Technical Support (TS)	-0.089	-1.061	0.033	0.827

Panel B: Distribution Channel Correlations[2]

	SQ	EU	PB	PTF	SP	AT	IU	PTR	TS
SQ	1.000								
EU	0.083	1.000							
PB	0.411	0.229	1.000						
PTF	0.550	0.041	0.293	1.000					
SP	0.420	0.091	0.089	0.439	1.000				
AT	0.620	-0.046	0.283	0.487	0.438	1.000			
IU	0.471	-0.014	0.219	0.464	0.436	0.552	1.000		
PTR	0.439	-0.076	0.169	0.470	0.434	0.551	0.714	1.000	
TS	0.297	0.365	0.482	0.265	0.208	0.135	0.203	0.141	1.000

Notes: [1] Standard deviations shown on diagonal in Panel A [2] All correlations |r| > 0.11 are significant at p < 0.05

4.2. Distribution Network Analysis

The analysis of distribution network effectiveness reveals significant variations across geographical regions and demographic segments, as presented in Table 3. The examination of regional distribution patterns demonstrates substantial differences in service quality effects between urban and rural areas ($\Delta\beta$=0.209, p<0.071). The practical significance of this finding is substantial, suggesting that urban distribution channels demonstrate 20.9% higher service quality impact on channel attitudes (β=0.605, p< 0.001) compared to rural networks (β=0.395, p<0.001). This difference has important implications for distribution channel design and resource allocation strategies.

Table 3: Regional and Demographic Distribution Effectiveness Analysis

Panel A: Regional Distribution Channel Analysis

Distribution Path	Rural (n=124)	Urban (n=171)	Path Difference	Significance
AT → IU	0.253***	0.240***	0.013	0.897
EU → AT	-0.203*	-0.018	-0.185	0.194
PB → AT	0.073	0.148**	-0.075	0.452
PTF → IU	0.094	0.115**	-0.021	0.808
SP → AT	0.312***	0.181**	0.131	0.216
SQ → AT	0.395***	0.605***	-0.209	0.071†
TS → AT	0.056	-0.196***	0.252	0.105
PTR×AT → IU	0.095	0.110*	-0.015	0.857

Panel B: Age-Based Distribution Channel Analysis

Distribution Path	Age Group Coefficients	Group Differences
	40-60 (n=153)	>60 (n=38)
AT → IU	0.223***	0.254***
EU → AT	-0.198**	-0.013
PB → AT	0.127	0.023
PTF → IU	0.026	0.149**
SP → AT	0.211***	0.089
SQ → AT	0.516***	0.687***
TS → AT	0.061	-0.006
PTR×AT → IU	0.123*	0.091

Notes:
p < 0.10; ** p < 0.05; *** p < 0.01 † Marginally significant at p < 0.10
Path coefficients represent standardized estimates
Difference tests based on multi-group analysis
Sample sizes: Rural (n=124), Urban (n=171); Age groups: 40-60 (n=153), >60 (n=38), <40 (n=104).
Path differences tested using PLS-MGA approach. Effect sizes (f^2) indicate practical significance of observed differences.

Security protocols demonstrate varying effectiveness across distribution regions, with rural areas showing stronger security effects on channel attitudes (β=0.312, p< 0.001) compared to urban regions (β=0.181, p<0.05). This finding indicates heightened security consciousness in rural distribution networks, potentially reflecting different risk perceptions across geographical segments. Technical support effectiveness also varies significantly, with urban

areas demonstrating stronger negative effects (β=-0.196, $p < 0.001$), suggesting potential overemphasis on technical support in urban distribution channels.

Demographic analysis reveals notable age-based variations in distribution network effectiveness. Service quality shows particularly strong effects among older users (β=0.687, $p<0.001$), while security protocols demonstrate stronger influences among younger users (β=0.420, $p< 0.001$). These age-based differences highlight the need for tailored distribution strategies across demographic segments. The impact of future perception on usage intention proves more significant among older (β=0.149, $p<0.05$) and younger users (β=0.154, $p<0.05$) compared to middle-aged users (β=0.026, n.s.).

Channel attitude maintains consistent positive effects across all demographic segments, with coefficients ranging from 0.223 to 0.256 (all $p<0.001$), indicating robust channel acceptance across user groups. However, the moderating effect of network readiness shows varying significance across age groups, suggesting differential impacts of technological preparedness on distribution channel effectiveness.

4.3. Hypothesis Testing Results

The structural model assessment reveals significant relationships among the hypothesized paths influencing digital healthcare distribution effectiveness. Table 4 presents comprehensive results of hypothesis testing, demonstrating strong support for the majority of proposed relationships in the distribution model.

Table 4: Distribution Model Results and Hypothesis Testing

Panel A: Direct Effects in Distribution Model

Hypothesis & Path	Coefficient (β)	T-statistics	f-square	Result
PB → AT	0.120**	2.357	0.017	Supported
EU → AT	-0.107	1.379	0.018	Not Supported
SQ → AT	0.501***	8.646	0.307	Supported
TS → AT	-0.084	1.578	0.009	Not Supported
SP → AT	0.245***	4.575	0.086	Supported
AT → IU	0.244***	4.565	0.070	Supported
PTR x AT →IU	0.101**	2.318	0.018	Supported
PTF → IU	0.102**	2.363	0.017	Supported

Panel B: Mediating Effects in Distribution Channels

Indirect Path	Original Effect	T-statistics	Result
EU → IU	-0.026	1.302	Not Significant
PB → IU	0.029**	2.053	Significant
SP → IU	0.060**	3.059	Significant
SQ → IU	0.122***	4.065	Significant
TS → IU	-0.021	1.537	Not Significant

Panel C: Model Performance Metrics

Endogenous Variable	R-square	Adjusted R-square
Channel Attitude	0.446	0.435
Usage Intention	0.562	0.554

Notes:
$p<0.10$; ** $p<0.05$; *** $p<0.01$
β represents standardized path coefficients
T-statistics obtained through bootstrapping (5000 samples)
f-square: 0.02 (small), 0.15 (medium), 0.35 (large) effects
R-square indicates substantial explanatory .
Direct effects, mediating effects, and model performance metrics presented in Panels A, B, and C respectively. All path coefficients derived from PLS-SEM analysis with bias-corrected confidence intervals.

The analysis demonstrates that service quality emerges as the strongest predictor of channel attitude in digital healthcare distribution (β=0.501, $p<0.001$, $f^2=0.307$), explaining approximately 30.7% of the variance in channel attitudes. This substantial effect size indicates that a one standard deviation improvement in service quality leads to a 0.501 standard deviation increase in positive channel attitudes, representing a practically significant impact for healthcare providers. Security protocols demonstrate the second strongest influence on channel attitudes (β=0.245, $p<0.001$, $f^2=0.086$), suggesting that enhanced security measures could improve channel attitudes by 24.5%, a finding particularly relevant for healthcare organizations implementing digital distribution strategies.

Distribution benefits show a moderate but significant positive effect on channel attitudes (β=0.120, $p<0.05$, $f^2= 0.017$), supporting H1. However, contrary to expectations, channel accessibility and technical support do not significantly influence channel attitudes (β=-0.107, n.s.; β= -0.084, n.s., respectively), leading to the rejection of H2 and H4. These unexpected findings suggest that traditional usability factors may be less crucial in healthcare distribution contexts compared to service quality and security considerations.

The mediating role of channel attitude receives strong empirical support (β=0.244, $p<0.001$, $f^2=0.070$), confirming H6. The analysis of indirect effects reveals significant mediating pathways, particularly for service quality (β= 0.122, $p<0.001$) and security protocols (β = 0.060, $p<0.05$). Network readiness demonstrates a significant moderating effect on the relationship between channel attitude and usage intention (β=0.101, $p<0.05$, $f^2=0.018$), supporting H7. Future perception of distribution channels shows a significant direct effect on usage intention (β=0.102, $p<0.05$, $f^2=0.017$), supporting H9 and confirming the importance of forward-looking perspectives in digital healthcare distribution.

The model demonstrates substantial explanatory power, accounting for 44.6% of variance in channel attitude ($R^2= 0.446$) and 56.2% in usage intention ($R^2=0.562$), indicating

robust predictive capability for digital healthcare distribution outcomes. These results provide strong empirical support for the proposed distribution model while highlighting the paramount importance of service quality and security protocols in digital healthcare distribution.

5. Discussion

5.1. Theoretical Implications for Distribution Science

This study makes substantial theoretical contributions to understanding digital healthcare distribution by integrating anticipatory governance perspectives with established distribution channel frameworks. Our findings extend current distribution theory in several significant ways. First, the research advances distribution channel theory by demonstrating how anticipatory elements and demographic variations influence digital healthcare delivery optimization. While previous studies by Andriopoulou et al. (2018) and Qi et al. (2020) focused primarily on technological infrastructure and network efficiency, our findings reveal that future perception significantly shapes current distribution channel adoption decisions, introducing a temporal dimension to distribution channel theory.

The strong influence of service quality on distribution channel attitudes (β=0.501, p<0.001) extends beyond previous findings by Bailey et al. (2021) and Orrange et al. (2021), demonstrating that in digital healthcare distribution, service quality surpasses traditional usability factors in importance. These finding challenges conventional distribution channel frameworks that emphasize ease of use and technical support as primary adoption drivers. Instead, our results suggest a paradigm shift where service quality and security protocols form the cornerstone of successful digital distribution networks.

Our research introduces future perception as a novel construct in distribution channel theory, demonstrating its significant effect on adoption intentions (β=0.102, p<0.01). This theoretical advancement aligns with recent work by Jungwirth and Haluza (2017) and Martin et al. (2022) but extends their findings by explicitly linking future orientation to current distribution channel effectiveness. The integration of anticipatory governance principles with distribution channel frameworks provides a more nuanced theoretical foundation for understanding technology adoption in healthcare contexts.

The identified regional variations in distribution effectiveness ($\Delta\beta$=0.209, p<0.071) contribute to distribution theory by highlighting the contextual nature of channel optimization. These findings extend recent work by Truong et al. (2022) and Papalamprakopoulou et al. (2024) by demonstrating how geographical and demographic factors moderate the relationship between service quality and channel attitudes. This understanding enhances the theoretical framework for digital distribution channel design and implementation across diverse service contexts.

5.2. Practical Implications for Distribution Management

Our findings offer significant practical implications for healthcare distribution managers and policymakers. The paramount importance of service quality in shaping channel attitudes suggests that distribution managers should prioritize service delivery excellence over technical sophistication. Recent studies by Zhu et al. (2023) and Leonard et al. (2023) emphasize the critical need for understanding factors influencing sustained telehealth adoption. Our research addresses this need by providing concrete guidelines for optimizing distribution channel performance.

Healthcare organizations should develop comprehensive security protocols that address both technical and perceptual aspects of digital distribution. The strong influence of security measures on channel attitudes (β=0.245, p<0.001) indicates that distribution managers must implement robust data protection measures while effectively communicating these security features to users. This aligns with findings by Wei et al. (2020) regarding the critical role of trust in facilitating technology acceptance across healthcare distribution networks.

The significant regional variations in distribution effectiveness necessitate tailored approaches to channel management. Distribution managers should develop region-specific strategies that account for local infrastructure capabilities and user characteristics. This recommendation extends beyond the accessibility considerations noted by Liu et al. (2019) to encompass comprehensive distribution network optimization strategies. Organizations should implement differentiated service delivery models that accommodate varying levels of technological readiness across different service regions.

The moderating effect of technological readiness (β= 0.101, p<0.01) suggests that distribution managers should develop tiered support systems based on users' technological proficiency. This approach differs from the one-size-fits-all model suggested in previous implementation studies and acknowledges the diverse technological capabilities within patient populations. Healthcare organizations should invest in targeted training programs and support mechanisms that address the specific needs of different user segments.

Furthermore, the significant role of future perception in driving adoption intentions suggests that distribution managers should actively communicate their technological roadmap and future service development plans. This

strategic communication should encompass planned improvements in distribution capabilities, upcoming technological integrations, and long-term commitments to digital service delivery. Such transparency can enhance user confidence in digital distribution channels and promote sustained engagement with healthcare services.

5.3. Limitations and Future Research Directions

While this study provides valuable insights into digital healthcare distribution optimization, several limitations should be acknowledged, offering opportunities for future research. First, the cross-sectional nature of our data limits causal inferences regarding the temporal dynamics of distribution channel adoption. Future longitudinal studies could examine how distribution channel effectiveness evolves over time, particularly focusing on the long-term impact of future perception on sustained channel usage. As suggested by recent work from Williams et al. (2023) and Bond (2023), longitudinal analyses could reveal important patterns in distribution channel optimization across different implementation phases.

The geographical scope of our study, while comprehensive within its context, may limit the generalizability of findings to other distribution environments. Future research should explore digital healthcare distribution in diverse cultural and economic contexts, examining how different healthcare systems and regulatory frameworks influence distribution channel effectiveness. Studies by Bustamante et al. (2023) and Abdullah et al. (2023) highlight significant disparities in channel accessibility across different populations, suggesting the need for broader cross-cultural investigations of distribution network optimization.

Future researchers should investigate the integration of emerging technologies such as artificial intelligence and blockchain in healthcare distribution networks. As indicated by Müller et al. (2021) and Milosevic (2020), these technologies could fundamentally transform distribution channel security and efficiency. Research could explore how advanced analytics and automated decision-making systems might enhance distribution network optimization and personalization of service delivery.

Additionally, future studies should examine the role of cross-channel integration in healthcare distribution networks. While our research focused primarily on digital channels, the increasing importance of omnichannel healthcare delivery suggests the need for investigating how traditional and digital channels can be effectively integrated. This aligns with recent findings by Dhaliwal et al. (2021) regarding the expansion of hybrid care models in primary healthcare delivery.

The measurement of future perception, while novel in our study, could be further refined in future research. Scholars might develop more comprehensive scales that capture additional dimensions of anticipatory governance in healthcare distribution. Such research could build upon our findings while incorporating insights from recent work by Takahashi et al. (2022) on the evolution of healthcare delivery systems.

These limitations and future directions highlight the dynamic nature of healthcare distribution research and the ongoing need for scholarly investigation in this rapidly evolving field.

6. Conclusion

This study advances our understanding of digital healthcare distribution optimization by integrating anticipatory governance perspectives with established distribution channel frameworks. Our findings reveal that service quality (β=0.501) and security protocols (β=0.245) significantly influence distribution channel attitudes, while traditional usability factors play a less prominent role than previously theorized. The incorporation of future perception as a novel construct (β=0.102) provides valuable insights into how anticipatory elements shape current distribution channel adoption decisions.

Theoretically, this research extends traditional distribution channel models by demonstrating how anticipatory elements and demographic variations influence digital healthcare delivery optimization. The strong influence of service quality and security measures on channel attitudes, combined with the significant role of future perception, establishes a new theoretical framework for understanding digital healthcare distribution effectiveness. Notably, our findings reveal important demographic variations in distribution patterns, particularly across urban-rural locations ($\Delta\beta$=0.209) and age groups, suggesting the need for tailored channel optimization strategies.

Practically, these findings provide healthcare organizations with evidence-based guidelines for distribution network optimization, emphasizing the importance of service quality enhancement and security protocol implementation. As healthcare systems continue to evolve, understanding both current adoption factors and future expectations becomes increasingly crucial for successful distribution channel implementation. This research provides a foundation for developing more effective, user-centered digital distribution networks while offering directions for future investigation in this rapidly advancing field.

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