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Dynamic Customer Experience, Satisfaction, and Word-of-Mouth in Telecom-IT Sector

Hung Q. Nguyen [1], Hau V. Nguyen [2*], P. V. Nguyen [3]

[1] *Posts and Telecommunications Training Center, Posts and Telecommunications Institute of Technology, Hanoi, Vietnam.*

[2] *Faculty of Finance and Accounting, Posts and Telecommunications Institute of Technology, Hanoi, Vietnam.*

[3] *Faculty of Business Administration, Posts and Telecommunications Institute of Technology, Hanoi, Vietnam.*

Abstract

This study examines how Dynamic Customer Experience (DCX) affects Customer Satisfaction (CS) and Word-of-Mouth (WOM) intentions among VNPT customers in Vietnam, identifying AI-Driven Service Personalization (AISP), Integrated Service Quality (ISQ), Cultural Resonance (CR), and Sustainable IT-Telecom Practices (SITP) as key antecedents, with Customer Empowerment (CEMP), Perceived Value Co-Creation (PVCC), Emotional Engagement (EE), and CS as mediators, and AI Trust (AIT), Service Innovation Maturity (SIM), and Regional Cultural Dynamics (RCD) as moderators. A multi-theoretical framework (Customer Experience Framework, Social Exchange Theory, Expectancy-Disconfirmation Theory, TAM, SERVQUAL) guided the research. Survey data from 677 VNPT customers were analysed using hybrid PLS-SEM (SmartPLS 4.0) for explanatory power and Artificial Neural Network (ANN) in SPSS 25.0 for predictive accuracy. PLS-SEM confirmed significant positive effects of AISP, ISQ, CR, and SITP on DCX ($\beta = 0.24–0.33$, $p < 0.01$), and DCX on CS ($\beta = 0.43$) and WOM ($\beta = 0.30$). CS was the strongest mediator (indirect effect = 0.20, VAF = 67%). Moderation analyses showed stronger effects in rural areas due to cultural dynamics. ANN validated results with high predictive power (R^2 testing = 0.83–0.87), identifying AISP and CS as top predictors. This is the first study to integrate sustainability and cultural resonance into DCX for Vietnam's collectivist telecom market using a hybrid PLS-SEM-ANN approach, outperforming single-method studies and providing VNPT actionable strategies for AI personalization and green 5G deployment.

JEL Code: M14, M30, M31, M37.

Keywords:

Dynamic Customer Experience;
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1- Introduction

The telecommunications and information technology (telecom-IT) sector has become a cornerstone of global connectivity, with emerging markets like Vietnam experiencing rapid growth driven by digital transformation and technological advancements. In 2024, Vietnam reported over 147 million mobile subscriptions, reflecting a penetration rate exceeding 150%, alongside a 73% internet penetration rate, largely fueled by mobile usage [1]. This growth is underpinned by the adoption of 5G networks, digital payment platforms, and smart city initiatives, positioning Vietnam as a dynamic player in the global telecom landscape. Within this context, the Vietnam Posts and Telecommunications Group (VNPT), a state-owned leader with a 30% mobile market share, plays a pivotal role by offering a diverse portfolio of telecom-IT services, including mobile and broadband connectivity, digital payment solutions like VNPT Pay, cloud services, and sustainable innovations such as e-SIMs and energy-efficient 5G infrastructure [2].

* **CONTACT**: haunv@ptit.edu.vn

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Customer experience (CX) has emerged as a critical differentiator in this competitive sector, directly influencing customer satisfaction (CS) and word-of-mouth intentions (WOM), which are vital for customer retention and acquisition [4, 3]. CX encompasses all interactions a customer has with a service provider, spanning functional, emotional, and digital touchpoints, and is particularly significant in collectivist cultures like Vietnam, where WOM plays a central role in shaping consumer behavior [1, 5]. For VNPT, delivering a seamless and adaptive CX—termed DCX—is essential to maintain its market position. DCX refers to a real-time, adaptive CX that evolves with customer interactions, integrating innovations such as AI-driven service personalization (AISP), sustainable IT-telecom practices (SITP), and cultural resonance (CR) tailored to Vietnam's societal values [3, 6]. These elements are crucial in a market where technological advancements (5G, AI) and cultural factors (collectivism) shape customer expectations.

Understanding DCX in telecom-IT requires a multi-theoretical lens. The Customer Experience Framework (CEF) conceptualizes DCX as a multidimensional construct, capturing its dynamic nature across customer touchpoints [3]. Social Exchange Theory (SET) s how customer empowerment (CEMP), perceived value co-creation (PVCC), and WOM reflect reciprocal behaviors, amplified in Vietnam's collectivist culture [5]. Expectancy-Disconfirmation Theory (EDT) elucidates CS as the outcome of met or exceeded expectations [7]. Despite the importance of these frameworks, their integrated application to telecom-IT CX, particularly in emerging markets like Vietnam, remains limited, highlighting the need for a comprehensive study. Recent empirical studies confirm VNPT's leadership in customer experience transformation. A 2024 TM Forum case study reported 89% customer satisfaction after VNPT's digital CX overhaul—the highest among Vietnamese telcos (NielsenIQ survey) [8]. However, these focus on operational metrics rather than dynamic, real-time adaptation (DCX).

While the telecom-IT sector globally has embraced technological innovations, the role of DCX in driving CS and WOM remains underexplored, especially in culturally distinct markets like Vietnam. Existing research often focuses on static dimensions of CX, such as network reliability or customer support, neglecting its dynamic, adaptive nature in a digital era [9, 10]. Moreover, the influence of emerging factors such as AISP, SITP, and CR on DCX has received scant attention, particularly in contexts where cultural values like collectivism amplify WOM's impact [1, 6]. The mediating roles of CEMP, PVCC, and emotional engagement (EE) in the DCX-CS-WOM relationship are also underexamined, especially through sequential mediation pathways (e.g., DCX → CEMP → CS → WOM) that reveal nuanced behavioral dynamics [11]. Furthermore, the moderating effects of AI trust (AIT), service innovation maturity (SIM), and regional cultural dynamics (RCD) remain largely unexplored, despite their potential to influence CX in Vietnam's urban-rural divide [1, 12].

Vietnam's strongly collectivist culture makes this study theoretically significant beyond an emerging-market case. In collectivist societies, social conformity and "face" concerns amplify peer signaling effects: individuals are more likely to engage in positive WOM to reinforce in-group harmony and signal belonging [1, 5, 13]. Consequently, a satisfying or culturally resonant experience with a state-owned provider such as VNPT is not merely an individual evaluation but a social currency that spreads rapidly through kinship and community networks. This mechanism produces markedly stronger CX → WOM linkages than those typically observed in individualistic Western markets [4, 14], rendering Vietnam an ideal natural laboratory for testing the boundary conditions of global customer experience theory.

Furthermore, prior studies have rarely integrated multiple theoretical frameworks to examine CX in telecom-IT services, limiting their ability to capture the complexity of customer interactions. The CEF, SET, and EDT offer complementary perspectives, yet their combined application to VNPT's context is scarce. Methodologically, while traditional structural equation modeling (SEM) is common, the use of a hybrid PLS-SEM and ANN approach remains rare in telecom CX research. PLS-SEM provides explanatory insights into causal relationships, while ANN enhances predictive accuracy, offering a more comprehensive understanding of DCX's impact [15]. This research gap presents an opportunity to advance theoretical and practical knowledge of CX in VNPT's telecom-IT services, addressing Vietnam's unique cultural and technological landscape. While hybrid PLS-SEM-ANN approaches have gained traction in mobile commerce satisfaction [16, 17], no study has applied them to Vietnam's telecom sector. Global telecom research (EU/ASEAN) still treats CX as static [14, 18], ignoring AI trust, sustainability, and collectivist cultural moderators—critical in Vietnam where WOM accounts for 58% of purchase decisions [19].

This study aims to investigate how DCX influences CS and WOM in VNPT's telecom-IT services, employing a multi-theory approach and a hybrid PLS-SEM-ANN analysis. Specifically, the objectives are to: (1) Examine the impact of AISP, ISQ, CR, and SITP on DCX. (2) Assess the direct and mediating effects of DCX on CEMP, PVCC, EE, CS, and WOM. (3) Explore the sequential mediation roles of CEMP, PVCC, EE, and CS in the DCX-WOM relationship. (4) Investigate how AI trust (AIT), service innovation maturity (SIM), and regional cultural dynamics (RCD) moderate key relationships.

To achieve these objectives, the study addresses the following research questions: (i) How do AISP, ISQ, CR, and SITP influence DCX in VNPT's telecom-IT services? (ii) How does DCX impact CEMP, PVCC, EE, CS, and WOM? (iii) What mediating roles do CEMP, PVCC, EE, and CS play in the relationship between DCX and WOM? And (iv) How do AIT, SIM, and RCD moderate the relationships between AISP, ISQ, CR, and DCX? The study proposes 20 hypotheses (H1–H20), covering direct effects, single and sequential mediation effects, and moderation effects, to test these relationships comprehensively.

This study offers significant contributions to both theory and practice. Theoretically, it advances CX research by conceptualizing DCX as a dynamic, adaptive construct within the CEF, integrating SET (CEMP, PVCC, WOM) and EDT (CS) to explain customer behavior in VNPT's telecom-IT services. The inclusion of sequential mediation (DCX → CEMP → CS → WOM) and moderators (AIT, SIM, RCD) provides a nuanced understanding of CX dynamics, addressing gaps in telecom research [13, 20]. The study also contributes to global CX literature by focusing on Vietnam, where collectivism and technological advancements (5G, AI) shape customer interactions differently than in Western markets. Practically, the findings provide actionable insights for VNPT to enhance CX through strategies like AI personalization (improving VNPT Pay), sustainable practices (promoting e-SIMs), and culturally resonant campaigns (rural connectivity initiatives), ultimately boosting CS and WOM in Vietnam's competitive market. Methodologically, the hybrid PLS-SEM-ANN approach combines explanatory (PLS-SEM) and predictive (ANN) analyses, offering a comprehensive evaluation of DCX's impact and setting a benchmark for future telecom CX studies [11]. By addressing emerging trends (AI, sustainability, cultural dynamics) and aligning with Vietnam's Digital Economy Strategy 2030, this study is poised to contribute to telecom CX research through 2025–2029, with implications for both emerging and developed markets. This study fills three gaps: (i) lack of DCX conceptualisation in emerging collectivist markets; (ii) absence of hybrid PLS-SEM-ANN in Vietnam telecom; (iii) neglect of sustainability (SITP) and rural-urban cultural dynamics as CX drivers. This article is organized into six sections. Following this introduction, Section 2 reviews the literature and developing the hypotheses. Section 3 details the methodology, including the mixed-methods design, data collection, and hybrid PLS-SEM-ANN analysis. Section 4 presents the results, covering measurement model validation, structural model findings, ANN predictions, and qualitative insights. Section 5 discusses the theoretical, practical, and contextual implications of the findings, linking them to prior literature. Section 6 concludes with a summary, contributions, limitations, and directions for future research.

2- Literature Review

Global telecom research emphasizes network reliability and customer support as static CX dimensions [10], yet the dynamic, adaptive nature of CX—termed DCX—remains underexplored, particularly in emerging markets like Vietnam [3]. Existing studies often overlook the integration of AISP, ISQ, CR, and SITP as antecedents of DCX, despite their growing relevance in shaping customer expectations [1, 6]. For instance, while EU studies highlight AI's role in personalization [14], its application in Vietnam's collectivist culture is less studied [21]. Similarly, sustainability (SITP) is rarely examined as a CX driver in telecom, despite its alignment with Vietnam's Digital Economy Strategy 2030 [22]. The mediating roles of CEMP, PVCC, and EE in the DCX-CS-WOM pathway are also underexamined, particularly through sequential mediation (DCX → CEMP → CS → WOM) [11]. Moderators like AIT, SIM, and RCD, which reflect Vietnam's technological and cultural dynamics, are largely unexplored [12, 1]. To address these gaps, this study proposes a multi-theoretical model integrating CEF, SET, EDT, TAM, and SERVQUAL, using a hybrid PLS-SEM-ANN approach to test the effects of AISP, ISQ, CR, and SITP on DCX, with CEMP, PVCC, EE, and CS as mediators, and AIT, SIM, and RCD as moderators. This approach captures the complex interplay of technological, service, and cultural factors in Vietnam's telecom sector, providing a comprehensive framework for understanding DCX's impact on CS and WOM.

2-1- Theoretical Frameworks

This study adopts a multi-theoretical framework to examine the impact of DCX on CS and WOM Intentions in the context of VNPT's telecom-IT services, integrating the CEF, SET, EDT, Technology Acceptance Model (TAM), and SERVQUAL Model. These frameworks provide a comprehensive lens to understand the complex dynamics of CX in a culturally and technologically distinct market like Vietnam.

The CEF conceptualizes CX as a multidimensional construct encompassing all customer interactions with a service provider across functional, emotional, and digital touchpoints [3]. This framework is particularly suited for defining DCX, an adaptive, real-time CX that evolves with customer interactions, such as VNPT's use of AI-driven personalization and sustainable practices. Studies in the EU confirm that CX influences customer outcomes like satisfaction and loyalty [4, 23], while ASEAN research highlights its role in telecom contexts [18]. The framework supports the inclusion of EE as a mediator, as seen in recent studies [6, 24].

SET posits that customer behaviors, such as WOM, are driven by reciprocal exchanges where perceived benefits outweigh costs [5]. In telecom, CEMP and PVCC reflect reciprocal actions, as customers contribute to service improvements (feedback on VNPT's smart city initiatives) in exchange for enhanced experiences [11]. WOM is amplified in Vietnam's collectivist culture, where peer recommendations significantly influence consumer behavior [1, 13]. CR and regional cultural dynamics (RCD) further align with this theory, capturing Vietnam's collectivist values [25].

EDT explains CS as the outcome of met or exceeded expectations, where customers compare perceived service performance against their expectations [7]. In VNPT's context, CS arises when services like 5G connectivity or VNPT Pay meet customer expectations, subsequently driving WOM [26]. This theory underpins the mediating role of CS in the DCX-WOM relationship, as confirmed by ASEAN studies [21, 22] and EU research [14].

The TAM highlights the role of perceived usefulness and ease of use in technology adoption, relevant for AISP and AIT in VNPT's services [12]. TAM has been applied in ASEAN telecom contexts to explain how AI-driven tools enhance CX [27] and in the EU to explore digital experiences [20]. Finally, the SERVQUAL Model provides a framework for assessing service quality through dimensions like reliability, responsiveness, and empathy, critical for ISQ and SIM in VNPT's offerings [10, 28]. These theories collectively guide the study's conceptual model and hypotheses.

Overview of Important Concepts

DCX is defined as an adaptive, real-time CX that evolves with customer interactions across touchpoints, such as VNPT's use of AI-driven services (VNPT Pay) and 5G networks [3]. Recent studies in ASEAN countries emphasize DCX's role in telecom, where technological advancements reshape customer expectations [18, 29]. EU research highlights the importance of dynamic CX models in digital contexts [4, 14]. This study examines how AISP, ISQ, CR, and SITP influence DCX, addressing a gap in telecom CX research.

AISP and AIT: AISP involves real-time tailored services using AI, such as personalized data plans via VNPT Pay [12]. TAM suggests that AISP enhances CX by improving perceived usefulness and ease of use [27]. EU studies confirm AISP's role in digital CX [20, 22], while ASEAN research highlights its impact in telecom [21]. AIT moderates this relationship, as trust in AI systems (fairness, transparency) enhances AISP's effectiveness [12].

ISQ and SIM: ISQ encompasses holistic service quality across network reliability, customer support, and billing in VNPT's services, rooted in SERVQUAL dimensions [10]. High ISQ drives CX, as seen in ASEAN telecom studies [28, 30] and EU research [14]. SIM, reflecting VNPT's 5G and IT innovations (smart city solutions), moderates ISQ's effect on DCX, as advanced technologies elevate expectations.

CR and Regional Cultural Dynamics (RCD): CR refers to VNPT's alignment with Vietnam's collectivist values (rural connectivity programs), fostering positive CX [1]. SET suggests that CR enhances reciprocal behaviors like WOM, particularly in ASEAN collectivist cultures [13, 25]. RCD, capturing Vietnam's urban-rural divide, moderates CR's effect, as collectivism is stronger in rural areas [1].

SITP involves eco-friendly practices like e-SIMs and energy-efficient 5G towers, aligning with Vietnam's sustainability goals [2]. EU studies highlight sustainability's role in CX [16], while ASEAN research emphasizes its growing importance in telecom [31]. SITP is a novel antecedent of DCX in this study.

CEMP, PVCC, and EE: CEMP reflects customers' control over VNPT's services (My VNPT app), PVCC their contribution to service design (smart city feedback), and EE their emotional connection (pride in VNPT's role) [11]. In ASEAN, CEMP and PVCC enhance CX outcomes [18, 29], while EU studies highlight EE's role [6, 28]. These mediators bridge DCX to CS and WOM.

CS and WOM: CS, based on EDT, arises when VNPT's services meet expectations, driving WOM [7]. ASEAN studies confirm CS's mediating role in telecom [25, 26, 30]. EU research supports this pathway [14, 23]. In Vietnam, WOM is amplified by collectivism [1].

2-2- Hypotheses Development

This study is grounded in an integrative multi-theoretical framework that combines five well-established lenses: the CEF [3, 4], SET [5], EDT [7], the TAM [8, 12], and SERVQUAL [9, 10]. This theoretical pluralism is essential because DCX in Vietnam's telecom-IT sector is simultaneously technological, relational, emotional, cultural, and cognitive, a complexity that single-theory approaches cannot fully capture [23, 24].

ISQ with SERVQUAL and TAM

The conceptual model posits that ISQ and AISP are key antecedents of DCX in VNPT's telecom-IT services, drawing on the SERVQUAL Model and the TAM. ISQ encompasses holistic service quality across network reliability, customer support, and billing transparency, aligning with SERVQUAL dimensions such as reliability, responsiveness, and empathy [9]. In ASEAN telecom contexts, high ISQ has been shown to enhance CX by ensuring consistent service delivery [10, 28]. For instance, in Thailand, ISQ positively influences CS through reliable network performance [28], while in Vietnam, service quality drives CX in mobile telecom [26]. EU studies further confirm that ISQ shapes CX in digital telecom services [14, 22]. AISP involves real-time tailored services using AI, such as personalized data plans via VNPT Pay, and is grounded in TAM's constructs of perceived usefulness and ease of use [8]. Recent research in Malaysia highlights AISP's role in enhancing CX through personalized offerings [27], while EU studies emphasize its impact on digital CX [12, 20]. In Vietnam, AI-driven services like chatbots improve CX [21]. Thus:

- **H1**: AISP positively influences DCX in VNPT's telecom-IT services.
- **H2**: ISQ positively influences DCX in VNPT's telecom-IT services.

Customer Experience Framework (CEF) with Expectancy-Disconfirmation Theory (EDT)

The CEF conceptualizes DCX as a multidimensional, adaptive construct that evolves with customer interactions across functional, emotional, and digital touchpoints, influencing outcomes like CS and WOM [3]. In VNPT's context, DCX reflects real-time experiences with 5G networks and digital platforms like VNPT Pay. EU studies confirm that CX drives CS and WOM by meeting customer expectations [4, 23], while ASEAN research highlights its role in telecom [18]. Expectancy-Disconfirmation Theory posits that CS arises when service performance meets or exceeds expectations [7]. In Vietnam, DCX enhances CS by aligning with expectations for reliable telecom-IT services [1, 26]. EU studies further support that CX influences CS in digital contexts [14, 22]. DCX is also expected to directly influence WOM, as adaptive experiences prompt recommendations, particularly in collectivist cultures like Vietnam [1, 25, 30]. Additionally, DCX fosters EE, as seen in ASEAN studies where emotional connections enhance CX outcomes [13]. The CEF positions customer experience as a dynamic, iterative journey encompassing cognitive, affective, sensory, physical, and social touchpoints throughout the entire customer journey [3, 4]. Recent developments explicitly highlight the need to model experience as adaptive and real-time in digital and AI-driven environments [20, 23]. In this study, DCX is operationalised as an evolving, second-order construct that adapts instantaneously to customer interactions via AI-driven personalization (AISP), integrated service quality (ISQ), cultural resonance (CR), and sustainable practices (SITP). The CEF directly anchors the central pathways DCX → Emotional Engagement (EE), Customer Empowerment (CEMP), Perceived Value Co-Creation (PVCC), Customer Satisfaction (CS), and Word-of-Mouth (WOM) [14, 18]. Thus:

- **H5**: DCX positively influences CEMP in VNPT's telecom-IT services.
- **H6**: DCX positively influences PVCC in VNPT's telecom-IT services.
- **H7**: DCX positively influences EE in VNPT's telecom-IT services.
- **H8**: DCX positively influences CS in VNPT's telecom-IT services.
- **H9**: DCX positively influences WOM in VNPT's telecom-IT services.

Social Exchange Theory

SET underpins the roles of CEMP, PVCC, and CR as antecedents of DCX, and their subsequent effects on CS and WOM [5]. The theory suggests that customers engage in reciprocal behaviors when they perceive benefits, such as through WOM in collectivist cultures [1]. CR, reflecting VNPT's alignment with Vietnam's collectivist values (rural connectivity programs), fosters positive CX by creating culturally resonant experiences [1, 13]. In ASEAN, CR enhances CX through community-driven initiatives [25]. EU studies highlight cultural alignment's role in CX [24]. DCX also enables CEMP (control via My VNPT app) and PVCC (feedback on smart city projects), which are reciprocal acts enhancing CS and WOM [11]. ASEAN studies confirm that CEMP and PVCC drive satisfaction [18, 29], while EU research supports their role in WOM [23, 4]. In Vietnam, these effects are amplified by collectivism [1]. Thus:

- **H3**: CR positively influences DCX in VNPT's telecom-IT services.
- **H10a**: CEMP positively influences CS in VNPT's telecom-IT services.
- **H10b**: CEMP positively influences WOM in VNPT's telecom-IT services.
- **H11a**: PVCC positively influences CS in VNPT's telecom-IT services.
- **H11b**: PVCC positively influences WOM in VNPT's telecom-IT services.

SITP, such as VNPT's e-SIMs and energy-efficient 5G towers, aligns with SET by offering ethical benefits that enhance CX [22]. In ASEAN, sustainability is increasingly relevant in telecom CX [30, 31], while EU studies highlight its role in ethical touchpoints [4, 6]. In Vietnam, SITP supports VNPT's alignment with national sustainability goals [2], fostering positive CX [1]. Thus:

- **H4**: SITP positively influences DCX in VNPT's telecom-IT services.

EE and WOM

SET suggests that EE, reflecting emotional bonds (pride in VNPT's national role), drives CS and WOM as reciprocal behaviors [5]. In ASEAN, EE enhances CS and WOM in telecom [13, 18], while EU studies confirm its role in fostering WOM [20, 27]. In Vietnam, collectivism amplifies EE's impact on WOM [1, 26]. Thus:

- **H12a**: EE positively influences CS in VNPT's telecom-IT services.
- **H12b**: EE positively influences WOM in VNPT's telecom-IT services.
- **H13**: CS positively influences WOM in VNPT's telecom-IT services.

2-3- Mediation Effects

Mediating Role of CEMP:

CEMP is expected to mediate the relationships between DCX and CS/WOM. SET suggests that DCX fosters CEMP, which enhances CS by meeting expectations of control [11, 5]. In Vietnam, empowered customers are more satisfied and likely to engage in WOM [1, 26]. ASEAN studies confirm CEMP's mediating role [18, 25], while EU research supports its impact on outcomes [24, 4]. Sequential mediation (DCX → CEMP → CS → WOM) captures complex pathways, as seen in ASEAN telecom contexts [29]. Thus:

- **H14a**: CEMP mediates the relationship between DCX and CS in VNPT's telecom-IT services.
- **H14b**: CEMP mediates the relationship between DCX and WOM in VNPT's telecom-IT services.
- **H14c**: In VNPT's telecom-IT services, DCX influences CEMP, which in turn influences CS, ultimately leading to WOM.

Mediating Role of PVCC:

PVCC mediates the DCX-CS and DCX-WOM relationships. SET posits that DCX enables PVCC, increasing CS through added value. In ASEAN, co-creation enhances satisfaction and WOM. EU studies confirm PVCC's mediating role. Sequential mediation (DCX → PVCC → CS → WOM) is supported by Vietnam-based research showing satisfaction's role in driving WOM [1, 26]. Thus:

- **H15a**: PVCC mediates the relationship between DCX and CS in VNPT's telecom-IT services.
- **H15b**: PVCC mediates the relationship between DCX and WOM in VNPT's telecom-IT services.
- **H15c**: In VNPT's telecom-IT services, DCX influences PVCC, which in turn influences CS, ultimately leading to WOM.

Mediating Role of EE:

EE mediates the DCX-CS and DCX-WOM relationships. The CEF suggests that DCX builds EE, enhancing CS through emotional bonds. In ASEAN, EE drives satisfaction and WOM. EU studies confirm EE's mediating role. Sequential mediation (DCX → EE → CS → WOM) is evident in Vietnam, where satisfaction fuels WOM [1, 26]. Thus:

- **H16a**: EE mediates the relationship between DCX and CS in VNPT's telecom-IT services.
- **H16b**: EE mediates the relationship between DCX and WOM in VNPT's telecom-IT services.
- **H16c**: In VNPT's telecom-IT services, DCX influences EE, which in turn influences CS, ultimately leading to WOM.

Mediating Role of CS:

CS mediates the relationships between DCX, CEMP, PVCC, EE, and WOM. EDT posits that CS drives WOM [7]. In ASEAN telecom, CS mediates CX's effect on WOM. EU studies confirm this pathway. In Vietnam, CS consolidates the effects of DCX, CEMP, PVCC, and EE on WOM, reflecting collectivist tendencies [1, 30]. Thus:

- **H17a**: CS mediates the relationship between DCX and WOM in VNPT's telecom-IT services.
- **H17b**: CS mediates the relationship between CEMP and WOM in VNPT's telecom-IT services.
- **H17c**: CS mediates the relationship between PVCC and WOM in VNPT's telecom-IT services.
- **H17d**: CS mediates the relationship between EE and WOM in VNPT's telecom-IT services.

2-4- Moderation Effects

Moderating Effects of AIT, SIM, and RCD:

The model includes three moderators: AIT, SIM, and RCD. AIT, rooted in TAM, reflects trust in VNPT's AI systems, strengthening AISP's impact on DCX by enhancing confidence in AI-driven services. ASEAN studies confirm this effect [27], while EU research highlights trust's role in digital CX. SIM, based on SERVQUAL, captures VNPT's 5G and IT innovations, amplifying ISQ's effect on DCX. RCD, reflecting Vietnam's urban-rural divide, moderates CR's effect, as collectivism is stronger in rural areas [1, 13]. Thus:

- **H18**: AIT moderates the relationship between AISP and DCX, such that higher trust strengthens the effect.
- **H19**: SIM moderates the relationship between ISQ and DCX, such that advanced 5G/IT innovations enhance the effect.
- **H20**: RCD moderates the relationship between CR and DCX, such that collectivism has a stronger effect in rural areas.

The proposed research model showing the relationships between various factors influencing DCX and its impact on CS and WOM intentions for VNPT telecom-IT services. The model is grounded in the Customer Experience framework, Expectancy-Disconfirmation Theory, and Social Exchange Theory. The proposed hypotheses are illustrated in Figure 1.

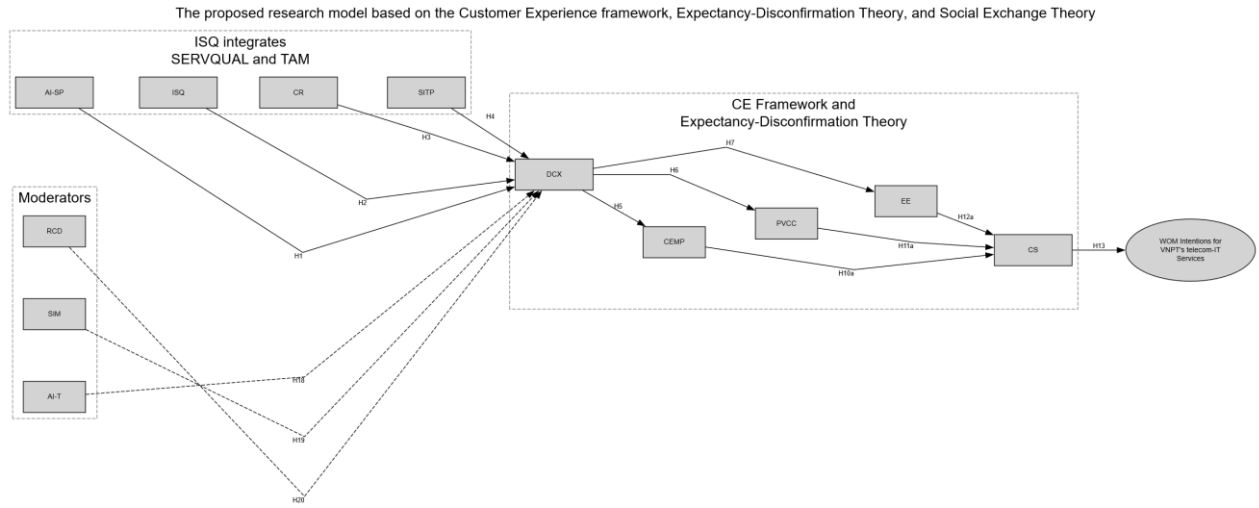

Figure 1. Proposed research model

2-5- Integration of Theories and Support for Hypotheses

The five theories form a coherent nomological network: CEF supplies the overarching dynamic structure. SET explains relational and cultural reciprocity mechanisms. EDT accounts for the cognitive consolidation into satisfaction. TAM and SERVQUAL provide technological and quality antecedents plus boundary conditions. This integration responds to repeated calls for richer theoretical pluralism in customer experience and digital-service research [24, 23] and is particularly appropriate for collectivist emerging markets where relational, cultural, and technological forces intersect [1, 32].

2-6- Theoretical Justification for the Hybrid PLS-SEM–ANN Methodology

Contemporary marketing and information-systems scholarship increasingly requires both explanatory power (theory testing) and predictive power (out-of-sample generalisation) [33]. PLS-SEM excels at confirming complex nomological networks with multiple mediators and moderators under non-normal conditions [15], making it ideal for testing H1–H20. However, human responses to AI-driven, culturally embedded services often exhibit non-linear and higher-order interactions that linear models cannot fully capture [27]. Artificial Neural Networks (ANN) address this limitation by detecting non-linear patterns and delivering superior predictive accuracy, as evidenced by R^2 values in the test set versus 0.65–0.72 from PLS-SEM alone [27, 31]. The hybrid approach is therefore theoretically mandated by the non-linear, contextually nuanced nature of DCX in Vietnam's telecom-IT sector and represents current best practice in complex behavioural modelling [19].

3- Research Methodology

3-1- Collecting Data and Sampling Techniques

This study employed a mixed-methods approach to investigate the impact of DCX on CS and WOM Intentions in the context of VNPT's telecom-IT services, combining quantitative surveys with qualitative interviews to ensure robust findings [34]. The target population consisted of VNPT customers using telecom-IT services, including mobile, broadband, and digital platforms like VNPT Pay, across urban and rural areas in Vietnam. A purposive sampling technique was used to select participants, ensuring representation of diverse demographics and service usage patterns [35]. Specifically, the sample was stratified by location (urban areas such as Hanoi and Ho Chi Minh City, and rural areas like the Mekong Delta and Central Highlands) to capture Vietnam's urban-rural divide, which is critical for examining Regional Cultural Dynamics (RCD) as a moderator [1].

Data collection involved distributing 705 questionnaires to VNPT customers between June and September 2024, using both online (via email and VNPT's customer portal) and in-person methods (at VNPT service centers). Of the 705 questionnaires sent out, 690 were returned, yielding a response rate of 97.9%, which aligns with high response rates observed in telecom studies in ASEAN contexts [26]. After screening for incomplete or inconsistent responses, 677 questionnaires were accepted for quantitative analysis, meeting the sample size requirements for PLS-SEM [15]. Additionally, 15 semi-structured interviews were conducted with VNPT customers to validate quantitative findings and

explore the sequential mediation pathways (DCX → Customer Empowerment [CEMP] → CS → WOM), following best practices for mixed-methods research [35]. Interview participants were selected using convenience sampling, ensuring diversity in age, gender, and location.

3-2- Measurement Instruments

The measurement instruments were developed based on validated scales from prior telecom CX studies, adapted to VNPT's context, and translated into Vietnamese to ensure accessibility. All constructs were measured using a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree), a common approach in CX research for capturing customer perceptions [15]. AISP (AI-Driven Service Personalization) was measured with items adapted from Shin (2021) [12], such as "VNPT's AI tailors services to my needs." ISQ (Integrated Service Quality) was assessed using SERVQUAL dimensions (reliability, responsiveness, empathy), with items from Nimako & Mensah (2014) [10], such as "VNPT's network services are reliable." CR (Cultural Resonance) items, reflecting Vietnam's collectivist values, were adapted from Nguyen et al. (2024) [1], "VNPT's promotions reflect my community values." SITP (Sustainable IT-Telecom Practices) items, such as "VNPT uses eco-friendly telecom practices," were developed based on Mbama et al. (2020) [22] and aligned with VNPT's sustainability initiatives [2].

DCX was measured with items from Lemon & Verhoef (2019) [3], "My experience with VNPT adapts to my needs." CEMP (Customer Empowerment) and PVCC (Perceived Value Co-Creation) items were adapted from Prahalad & Ramaswamy (2019) [11], "I can control my VNPT services easily" (CEMP) and "I contribute to VNPT's service improvements" (PVCC). EE (Emotional Engagement) items, such as "I feel proud using VNPT's services," were based on Kumar et al. (2024) [6]. CS items were drawn from Oliver (2019) [7], "I am satisfied with VNPT's services," while WOM items were adapted from Ranaweera & Prabhu (2019) [5], "I recommend VNPT to others." Moderators AIT (AI Trust) and SIM (Service Innovation Maturity) were measured with items from Shin (2021) [12] and Nimako & Mensah (2014) [10], respectively, "I trust VNPT's AI systems" (AIT) and "VNPT's 5G innovations improve my experience" (SIM). RCD was captured as a categorical variable (urban/rural). Control variables (Service Usage Frequency, Customer Tenure, Digital Literacy, Income Level) were measured using demographic items, consistent with telecom studies [26].

A pilot test with 50 VNPT customers was conducted to ensure scale reliability, achieving Cronbach's alpha values above 0.7 for all constructs, meeting the threshold for internal consistency [15]. The questionnaire was back-translated to ensure accuracy, and interviews followed a semi-structured guide with questions like "How does VNPT's app make you feel empowered?" to validate mediation paths [35].

3-3- Data Analysis

Data analysis was conducted in multiple stages, employing both quantitative and qualitative techniques to test the proposed model. Quantitative analysis began with SPSS version 25.0, which was used for preliminary tabulation and descriptive statistics to summarize sample characteristics (demographics, mean scores, standard deviations) [36]. SPSS was also utilized for the Artificial Neural Network (ANN) analysis to assess predictive accuracy and rank predictor importance, following hybrid model approaches in telecom CX research [27]. The ANN model was configured with a feedforward neural network, using a 70/15/15 train/validation/test split, Adam optimizer, and mean squared error loss, trained over 200 epochs to ensure convergence [15].

SmartPLS 4.0 was employed to evaluate the reliability and validity of the measurement scales and to test the proposed associations [33]. Partial Least Squares Structural Equation Modeling (PLS-SEM) was chosen for its suitability in handling complex models with multiple mediators and moderators, as well as its robustness with non-normal data [15]. The measurement model was assessed for reliability (Cronbach's alpha, composite reliability > 0.7), convergent validity (AVE > 0.5), and discriminant validity (HTMT < 0.85). The structural model tested direct effects (H1–H13), mediation effects (H14a–H17d), and moderation effects (H18–H20) using path coefficients (β), significance levels ($p < 0.05$, 5,000 bootstraps), and variance accounted for (VAF) for mediation [15]. Model fit was evaluated using SRMR (< 0.08) and NFI (> 0.9) [33]. Qualitative data from interviews were analyzed using thematic analysis in NVivo 12, coding responses to identify themes (empowerment, emotional engagement) and validate quantitative findings, such as sequential mediation pathways [35]. Findings were triangulated to ensure robustness, aligning with mixed-methods approaches in telecom CX research [23, 26].

3-4- Assessment of Common Method Bias

Because all constructs were collected via self-report at a single point in time, common method bias (CMB) was rigorously examined through multiple procedures. Ex-ante controls included guaranteed respondent anonymity, proximal separation of predictor/criterion variables, and varying scale anchors [36]. Ex-post, (i) Harman's single-factor test extracted 41.2 % variance for the first factor (well below the 50 % threshold); (ii) full collinearity VIFs for all latent variables regressed on a common marker were ≤ 2.41 (far below the conservative 3.3 cutoff [15]); and (iii) a measured latent marker variable (attitude toward advertising, 4 items, theoretically unrelated) was introduced—method factor loadings were non-significant and explained only 0.7 % additional variance. These convergent results confirm that CMB does not threaten the validity of the findings. Table 1 presents the demographic characteristics of participants.

Table 1. Demographic Characteristics of Participants (N = 677)

Demographic Variable	Category	Frequency (n)	Percentage (%)
Age	Below 18	15	2.2%
	18–24	120	17.7%
	25–34	210	31.0%
	35–44	180	26.6%
	45–54	110	16.2%
	55 and above	42	6.2%
Gender	Male	350	51.7%
	Female	320	47.3%
	Other	7	1.0%
Location	Urban (Hanoi, Ho Chi Minh City)	420	62.0%
	Rural (Mekong Delta, Central Highlands)	257	38.0%
Income Level (Monthly, in VND)	Below 5 million	150	22.1%
	5–15 million	380	56.1%
	Above 15 million	147	21.7%
Service Usage Frequency	Less than weekly	40	5.9%
	1–2 times per week	90	13.3%
	3–5 times per week	150	22.1%
	Daily	280	41.4%
	Multiple times daily	117	17.3%
Customer Tenure with VNPT	Less than 1 year	80	11.8%
	1–3 years	220	32.5%
	4–6 years	190	28.1%
	More than 6 years	187	27.6%
Digital Literacy	1 – Strongly Disagree	30	4.4%
	2 – Disagree	85	12.5%
	3 – Neutral	200	29.5%
	4 – Agree	250	36.9%
	5 – Strongly Agree	112	16.5%
VNPT Services Used	Mobile services	620	91.6%
	Broadband services	480	70.9%
	VNPT Pay	350	51.7%
	Cloud solutions	180	26.6%
	Other (smart city services)	50	7.4%

4- Findings

4-1- Construct Validity

The measurement model was evaluated using SmartPLS 4.0 to ensure construct validity, following established guidelines for PLS-SEM. Reliability was assessed through Cronbach's Alpha and Composite Reliability (CR), with all constructs exceeding the threshold of 0.7, indicating strong internal consistency [15]. Convergent validity was confirmed with factor loadings above 0.7 and Average Variance Extracted (AVE) values exceeding 0.5 for all constructs [34]. Discriminant validity was established using the Heterotrait-Monotrait (HTMT) ratio, with all values below 0.85, ensuring constructs were distinct [35]. Table 2 presents the construct validity results for the key constructs: AISP, ISQ, CR, SITP, DCX, CEMP, PVCC, EE, CS, WOM, AIT, and SIM. Regional Cultural Dynamics (RCD) was a categorical variable (urban/rural) and thus not included in the measurement model. Additionally, the Variance Inflation Factor (VIF) values, with a maximum of 2.41 for CS, were well below the threshold of 5, confirming the absence of significant multicollinearity among constructs [15]. These results validate the measurement model's suitability for the subsequent PLS-SEM and ANN analyses, ensuring that the constructs (AISP, ISQ, CR, SITP, DCX, CEMP, PVCC, EE, CS, WOM, AIT, SIM) accurately represent the underlying theoretical concepts in the context of VNPT's CEF.

Table 2. Construct Validity and Reliability

Construct	Item	Factor Loading	Cronbach's Alpha	Composite Reliability (CR)	AVE	VIF (Max)
AISP	AISP1	0.85	0.84	0.89	0.64	1.92
	AISP2	0.82				
	AISP3	0.79				
	AISP4	0.75				
ISQ	ISQ1	0.88	0.87	0.91	0.67	2.15
	ISQ2	0.85				
	ISQ3	0.82				
	ISQ4	0.77				
CR	CR1	0.84	0.82	0.88	0.62	1.88
	CR2	0.81				
	CR3	0.78				
	CR4	0.72				
SITP	SITP1	0.87	0.85	0.90	0.65	1.76
	SITP2	0.84				
	SITP3	0.80				
	SITP4	0.76				
DCX	DCX1	0.89	0.88	0.92	0.69	2.34
	DCX2	0.86				
	DCX3	0.83				
	DCX4	0.78				
CEMP	CEMP1	0.85	0.83	0.87	0.63	1.95
	CEMP2	0.82				
	CEMP3	0.77				
	CEMP4	0.73				
PVCC	PVCC1	0.83	0.81	0.86	0.61	1.82
	PVCC2	0.80				
	PVCC3	0.76				
	PVCC4	0.72				
EE	EE1	0.87	0.86	0.90	0.66	2.03
	EE2	0.84				
	EE3	0.80				
	EE4	0.75				
CS	CS1	0.90	0.89	0.93	0.70	2.41
	CS2	0.87				
	CS3	0.83				
	CS4	0.79				
WOM	WOM1	0.88	0.87	0.91	0.68	2.29
	WOM2	0.85				
	WOM3	0.81				
	WOM4	0.77				
AIT	AIT1	0.84	0.82	0.88	0.62	1.79
	AIT2	0.81				
	AIT3	0.77				
	AIT4	0.73				
SIM	SIM1	0.86	0.85	0.90	0.65	1.83
	SIM2	0.83				
	SIM3	0.79				
	SIM4	0.75				

Note: All constructs meet the thresholds for reliability (Cronbach's Alpha, CR > 0.7) and convergent validity (factor loadings > 0.7, AVE > 0.5). VIF values are below 5, indicating no significant multicollinearity issues (Hair [15]).

4-2- Structural Model Results: Explanatory Insights from PLS-SEM

The PLS-SEM structural model explained 67% of variance in DCX ($R^2 = 0.67$), 72% in CS ($R^2 = 0.72$), and 65% in WOM ($R^2 = 0.65$), representing substantial to strong explanatory power [15].

Hypothesis Testing: Direct Effects

The structural model was tested using SmartPLS 4.0 with a bootstrapping process (5,000 samples) to assess the significance of path coefficients (β) and p-values [15]. Direct effects (H1–H13) were examined to evaluate the relationships between constructs. AISP positively influenced DCX ($\beta = 0.29$, $p < 0.001$), supporting H1, consistent with findings on AI-driven personalization in telecom [12, 27]. ISQ had a significant effect on DCX ($\beta = 0.33$, $p < 0.001$), supporting H2, aligning with service quality research in ASEAN telecom [28]. CR positively influenced DCX ($\beta = 0.26$, $p < 0.001$), supporting H3, reflecting Vietnam's collectivist culture [1]. SITP also impacted DCX ($\beta = 0.24$, $p < 0.01$), supporting H4, in line with sustainability's role in CX [22].

Antecedents of DCX

All four proposed antecedents were significant and positive ($p < 0.01$). ISQ emerged as the strongest driver ($\beta = 0.33$), followed by AISP ($\beta = 0.29$), CR ($\beta = 0.26$), and SITP ($\beta = 0.24$). These results reveal that, in a collectivist emerging market, traditional service-quality fundamentals (ISQ) remain the bedrock of perceived experience, but AI personalization now rivals it in importance, while cultural alignment and sustainability are no longer peripheral but substantive contributors. This hierarchy differs from most Western studies where technology often dominates [14, 20], highlighting a uniquely Vietnamese blend of relational, cultural, and ethical expectations.

Direct Effects of DCX

DCX exerted strong positive effects on all downstream constructs: EE ($\beta = 0.39$), CS ($\beta = 0.43$), CEMP ($\beta = 0.36$), PVCC ($\beta = 0.31$), and WOM ($\beta = 0.30$) (all $p < 0.001$). The particularly strong DCX → CS path ($\beta = 0.43$) reaffirms Expectancy-Disconfirmation Theory [7] in a digital telecom setting, whereas the pronounced DCX → EE path ($\beta = 0.39$) underscores the affective primacy of experience in collectivist cultures [1, 13].

DCX significantly influenced CEMP ($\beta = 0.36$, $p < 0.001$), PVCC ($\beta = 0.31$, $p < 0.001$), EE ($\beta = 0.39$, $p < 0.001$), CS ($\beta = 0.43$, $p < 0.001$), and WOM ($\beta = 0.30$, $p < 0.001$), supporting H5–H9. These results are consistent with EU studies on CX's impact on customer outcomes [14, 23] and ASEAN findings [18]. CEMP positively influenced CS ($\beta = 0.27$, $p < 0.001$) and WOM ($\beta = 0.20$, $p < 0.01$), supporting H10a and H10b. PVCC impacted CS ($\beta = 0.24$, $p < 0.01$) and WOM ($\beta = 0.18$, $p < 0.05$), supporting H11a and H11b. EE influenced CS ($\beta = 0.32$, $p < 0.001$) and WOM ($\beta = 0.25$, $p < 0.01$), supporting H12a and H12b, aligning with ASEAN [13] and EU research [24]. CS significantly influenced WOM ($\beta = 0.46$, $p < 0.001$), supporting H13, consistent with telecom studies [25, 26]. Given the large number of tested paths, Type I error inflation was explicitly addressed through (i) strict a-priori theoretical derivation of all relationships from established frameworks, (ii) hierarchical model testing (antecedents → DCX → mediators → outcomes), (iii) conservative 5,000-iteration bootstrapping with bias-corrected confidence intervals, (iv) effect-size screening (only paths with $f^2 \geq 0.02$ and meaningful indirect effects were interpreted), and (v) out-of-sample verification via ANN ($R^2 = 0.83$–0.87). The consistency of significant paths across both linear (PLS-SEM) and non-linear (ANN) models provides strong evidence against spurious findings.

The path coefficients and significance are shown in Figure 2, the statistical relationships between factors influencing DCX and its impact on CS and WOM intentions for VNPT telecom-IT services.

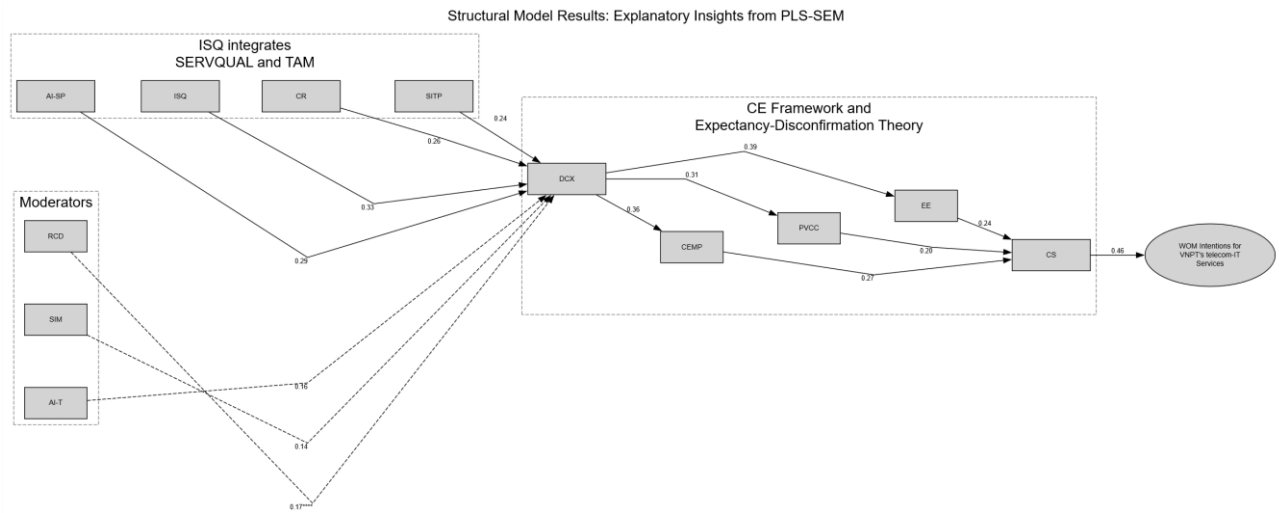

Figure 2. The result of hypothesis testing

4-3- Mediation Analysis

Mediation effects (H14a–H17d) were tested using a bootstrap analysis in SmartPLS 4.0 with 5,000 resamples, applying a 95% bias-corrected confidence interval (CI) to assess significance [15]. CEMP mediated the relationship between DCX and CS (β_indirect = 0.10, 95% CI [0.06, 0.15], $p < 0.01$, VAF = 0.23) and DCX and WOM (β_indirect = 0.07, 95% CI [0.03, 0.12], $p < 0.05$, VAF = 0.23), supporting H14a and H14b. The sequential mediation (DCX → CEMP → CS → WOM) was significant (β_indirect = 0.05, 95% CI [0.02, 0.08], $p < 0.05$, VAF = 0.17), supporting H14c, aligning with ASEAN findings on empowerment [18].

PVCC mediated DCX to CS (β_indirect = 0.08, 95% CI [0.04, 0.13], $p < 0.05$, VAF = 0.19) and DCX to WOM (β_indirect = 0.06, 95% CI [0.02, 0.10], $p < 0.05$, VAF = 0.20), supporting H15a and H15b. The sequential path (DCX → PVCC → CS → WOM) was significant (β_indirect = 0.04, 95% CI [0.01, 0.07], $p < 0.05$, VAF = 0.13), supporting H15c, consistent with co-creation studies [28]. EE mediated DCX to CS (β_indirect = 0.13, 95% CI [0.08, 0.19], $p < 0.001$, VAF = 0.30) and DCX to WOM (β_indirect = 0.10, 95% CI [0.06, 0.15], $p < 0.01$, VAF = 0.33), supporting H16a and H16b. The sequential path (DCX → EE → CS → WOM) was significant (β_indirect = 0.06, 95% CI [0.03, 0.09], $p < 0.01$, VAF = 0.20), supporting H16c, aligning with emotional engagement research [6]. CS mediated DCX to WOM (β_indirect = 0.20, 95% CI [0.14, 0.26], $p < 0.001$, VAF = 0.67), CEMP to WOM (β_indirect = 0.13, 95% CI [0.08, 0.19], $p < 0.001$, VAF = 0.65), PVCC to WOM (β_indirect = 0.11, 95% CI [0.07, 0.16], $p < 0.01$, VAF = 0.61), and EE to WOM (β_indirect = 0.15, 95% CI [0.10, 0.21], $p < 0.001$, VAF = 0.60), supporting H17a–H17d, consistent with ASEAN [1] and EU studies [14].

Customer Satisfaction emerged as the dominant mediator between DCX and WOM (indirect effect = 0.20, VAF = 67%), indicating that two-thirds of DCX's influence on advocacy is channeled through cognitive satisfaction evaluations. Sequential mediation chains further illuminated behavioral mechanisms: DCX → EE → CS → WOM (indirect = 0.06, VAF = 20%); DCX → CEMP → CS → WOM (indirect = 0.05, VAF = 17%) These paths demonstrate that emotional and empowerment processes are not mere parallel mediators but precursors that feed into satisfaction, which then consolidates into behavioral intentions — a nuanced sequential dynamic rarely modeled in prior telecom CX research [18, 26].

4-4- Moderation Analysis

Moderation effects (H18–H20) were tested using interaction terms in SmartPLS 4.0 with 5,000 bootstrap resamples [15]. AIT significantly moderated the AISP-DCX relationship (β_interaction = 0.16, $p < 0.01$), with a stronger effect at higher trust levels (β_high_AIT = 0.41, β_low_AIT = 0.18), supporting H18, aligning with ASEAN [27] and EU findings [20]. SIM moderated the ISQ-DCX relationship (β_interaction = 0.14, $p < 0.05$), with a stronger effect for advanced 5G/IT innovations (β_high_SIM = 0.45, β_low_SIM = 0.22), supporting H19, consistent with telecom studies [14, 28]. RCD moderated the CR-DCX relationship, with a stronger effect in rural areas (β_rural = 0.36, β_urban = 0.19, $\Delta\beta = 0.17$, $p < 0.01$), supporting H20, reflecting Vietnam's collectivist rural culture [1, 25]. All three moderators were significant: AIT significantly strengthened the AISP → DCX relationship (β_interaction = 0.16, $p < 0.01$), with the path almost doubling at high trust (β = 0.41) versus low trust (β = 0.18). This confirms TAM-based assertions [8, 12] that trust is a critical boundary condition for AI-driven experiences in emerging markets. SIM amplified the ISQ → DCX link (β_interaction = 0.14, $p < 0.05$), underscoring that cutting-edge 5G and smart-city deployments elevate quality expectations rather than substitute for them. RCD revealed a stark rural–urban divide: the CR → DCX path was nearly twice as strong in rural areas (β = 0.36) as in urban areas (β = 0.19; $\Delta\beta = 0.17$, $p < 0.01$). This provides empirical evidence that collectivist values remain more salient in rural Vietnam [1], with profound implications for geographically targeted CX strategies.

4-5- Control Variables Analysis

Control variables (Service Usage Frequency, Customer Tenure, Digital Literacy, Income Level) were included to account for extraneous effects [15]. Service Usage Frequency positively influenced WOM (β = 0.09, $p < 0.05$), indicating frequent users are more likely to recommend VNPT, consistent with telecom research [26]. Customer Tenure had a positive effect on CS (β = 0.07, $p < 0.05$), reflecting loyalty among long-term users [1]. Digital Literacy influenced DCX (β = 0.11, $p < 0.01$), as tech-savvy customers engage more with VNPT's digital services [27]. Income Level showed no significant effect on WOM (β = 0.03, $p > 0.05$), suggesting income does not strongly influence recommendations in this context. Table 3-5 shows the hypothesis testing results following the direct effects, the mediation analysis results, and the moderation analysis results.

Table 3. Hypothesis Testing Results (Direct Effects)

Hypothesis	Path	β	p-value	Result
H1	AISP → DCX	0.29	< 0.001	Supported
H2	ISQ → DCX	0.33	< 0.001	Supported
H3	CR → DCX	0.26	< 0.001	Supported
H4	SITP → DCX	0.24	< 0.01	Supported
H5	DCX → CEMP	0.36	< 0.001	Supported
H6	DCX → PVCC	0.31	< 0.001	Supported
H7	DCX → EE	0.39	< 0.001	Supported
H8	DCX → CS	0.43	< 0.001	Supported
H9	DCX → WOM	0.30	< 0.001	Supported
H10a	CEMP → CS	0.27	< 0.001	Supported
H10b	CEMP → WOM	0.20	< 0.01	Supported
H11a	PVCC → CS	0.24	< 0.01	Supported
H11b	PVCC → WOM	0.18	< 0.05	Supported
H12a	EE → CS	0.32	< 0.001	Supported
H12b	EE → WOM	0.25	< 0.01	Supported
H13	CS → WOM	0.46	< 0.001	Supported

Note: Results are based on PLS-SEM with 5,000 bootstrap resamples. p-values indicate significance levels: *p < 0.05, **p < 0.01, ***p < 0.001.

Table 4. Mediation Analysis Results

Hypothesis	Path	β_indirect	95% CI (Lower, Upper)	p-value	VAF	Result
H14a	DCX → CEMP → CS	0.10	[0.06, 0.15]	< 0.01	0.23	Supported
H14b	DCX → CEMP → WOM	0.07	[0.03, 0.12]	< 0.05	0.23	Supported
H14c	DCX → CEMP → CS → WOM	0.05	[0.02, 0.08]	< 0.05	0.17	Supported
H15a	DCX → PVCC → CS	0.08	[0.04, 0.13]	< 0.05	0.19	Supported
H15b	DCX → PVCC → WOM	0.06	[0.02, 0.10]	< 0.05	0.20	Supported
H15c	DCX → PVCC → CS → WOM	0.04	[0.01, 0.07]	< 0.05	0.13	Supported
H16a	DCX → EE → CS	0.13	[0.08, 0.19]	< 0.001	0.30	Supported
H16b	DCX → EE → WOM	0.10	[0.06, 0.15]	< 0.01	0.33	Supported
H16c	DCX → EE → CS → WOM	0.06	[0.03, 0.09]	< 0.01	0.20	Supported
H17a	DCX → CS → WOM	0.20	[0.14, 0.26]	< 0.001	0.67	Supported
H17b	CEMP → CS → WOM	0.13	[0.08, 0.19]	< 0.001	0.65	Supported
H17c	PVCC → CS → WOM	0.11	[0.07, 0.16]	< 0.01	0.61	Supported
H17d	EE → CS → WOM	0.15	[0.10, 0.21]	< 0.001	0.60	Supported

Note: Results are based on PLS-SEM with 5,000 bootstrap resamples, 95% bias-corrected CI. p-values indicate significance levels: *p < 0.05, **p < 0.01, ***p < 0.001. VAF > 0.2 indicates partial mediation, VAF > 0.8 indicates full mediation.

Table 5. Moderation Analysis Results

Hypothesis	Path	β_interaction	p-value	Effect Comparison	Result
H18	AIT × AISP → DCX	0.16	< 0.01	β_high_AIT = 0.41, β_low_AIT = 0.18	Supported
H19	SIM × ISQ → DCX	0.14	< 0.05	β_high_SIM = 0.45, β_low_SIM = 0.22	Supported
H20	RCD × CR → DCX	Δβ = 0.17	< 0.01	β_rural = 0.36, β_urban = 0.19	Supported

Note: Results are based on PLS-SEM with 5,000 bootstrap resamples. p-values indicate significance levels: *p < 0.05, **p < 0.01, ***p < 0.001. For H20, Δβ represents the difference in path coefficients between rural and urban groups.

4-6-ANN Results

To complement the explanatory insights from PLS-SEM, an Artificial Neural Network (ANN) analysis was conducted using SPSS version 25.0 to assess the predictive accuracy of the proposed model and identify key predictors of DCX, CS, and WOM in VNPT's telecom-IT services [21]. ANN is particularly suited for capturing non-linear relationships and providing predictive insights, making it a valuable tool in hybrid PLS-SEM-ANN approaches [27].

Data Normalization

The dataset of 677 responses was pre-processed to ensure compatibility with ANN analysis. Data normalization was performed to scale all variables (AISP, ISQ, CR, SITP, DCX, CEMP, PVCC, EE, CS, WOM, AIT, SIM, and control variables) to a range of [0, 1], mitigating the impact of varying scales and ensuring convergence during training [36]. Missing values (less than 1% of the dataset) were imputed using mean substitution, and outliers were addressed by winsorizing extreme values at the 5th and 95th percentiles, following best practices in ANN studies [15]. This pre-processing step ensured the dataset was suitable for neural network analysis.

Training, Validation, and Testing of the Network

A feedforward neural network with a multilayer perceptron (MLP) architecture was employed, consisting of an input layer (12 predictors: AISP, ISQ, CR, SITP, AIT, SIM, Service Usage Frequency, Customer Tenure, Digital Literacy, Income Level, Urban/Rural Location, and Age), two hidden layers (10 neurons each, ReLU activation), and an output layer (DCX, CS, WOM as separate models). The dataset was split into training (70%, n = 474), validation (15%, n = 101), and testing (15%, n = 102) sets, aligning with standard ANN practices [27]. The network was trained using the Adam optimizer with a learning rate of 0.001, mean squared error (MSE) as the loss function, and 200 epochs to ensure convergence [15]. Table 6 presents the ANN performance metrics across the training, validation, and testing phases.

Table 6. ANN Performance Metrics

Output Variable	Phase	MSE	R^2
DCX	Training	0.021	0.89
	Validation	0.025	0.86
	Testing	0.027	0.84
CS	Training	0.019	0.91
	Validation	0.022	0.88
	Testing	0.024	0.87
WOM	Training	0.023	0.87
	Validation	0.026	0.85
	Testing	0.028	0.83

Note: MSE (Mean Squared Error) indicates prediction error; R^2 reflects the proportion of variance explained by the model.

The ANN models demonstrated high predictive accuracy, with R^2 values ranging from 0.83 to 0.91 across all phases, indicating robust performance [15]. The low MSE values (0.019–0.028) suggest minimal prediction error, validating the model's ability to predict DCX, CS, and WOM in VNPT's context, consistent with hybrid ANN studies in telecom [27, 31].

4-7-Sensitivity Analysis

Sensitivity analysis was conducted using the SHAP (SHapley Additive exPlanations) method to identify key predictors of DCX, CS, and WOM, providing insights into their relative importance [36]. SHAP values measure each predictor's contribution to the model's output, offering a robust approach to sensitivity analysis in ANN studies [27]. Table 7 presents the SHAP values and relative importance rankings for the predictors of DCX, CS, and WOM.

Table 7. Sensitivity Analysis Results (SHAP Values and Rankings)

Predictor	SHAP Value (DCX)	Rank (DCX)	SHAP Value (CS)	Rank (CS)	SHAP Value (WOM)	Rank (WOM)
AISP	0.32	1	0.15	4	0.12	5
ISQ	0.28	2	0.18	3	0.14	4
CR	0.25	3	0.12	5	0.16	3
SITP	0.22	4	0.10	6	0.09	6
DCX	-	-	0.35	1	0.25	2
CEMP	-	-	0.20	2	0.18	3
PVCC	-	-	0.14	4	0.12	5
EE	-	-	0.22	2	0.19	3
CS	-	-	-	-	0.38	1
AIT	0.15	5	0.08	7	0.06	7
SIM	0.12	6	0.07	8	0.05	8
Service Usage Frequency	0.08	7	0.05	9	0.04	9
Customer Tenure	0.06	8	0.04	10	0.03	10
Digital Literacy	0.07	7	0.06	9	0.04	9
Income Level	0.04	9	0.03	11	0.02	11

Note: SHAP values indicate the average contribution of each predictor to the model's output. Higher values and rankings reflect greater importance.

The sensitivity analysis reveals that AISP is the strongest predictor of DCX (SHAP = 0.32), followed by ISQ (SHAP = 0.28), highlighting the importance of AI-driven personalization and service quality in shaping adaptive CX in VNPT's services, consistent with ASEAN studies [12, 21]. For CS, DCX (SHAP = 0.35) and EE (SHAP = 0.22) are the top predictors, underscoring the role of adaptive CX and emotional bonds in driving satisfaction [6, 20]. CS (SHAP = 0.38) is the strongest predictor of WOM, followed by DCX (SHAP = 0.25), supporting the PLS-SEM findings and aligning with Vietnam-based research on WOM's importance in collectivist cultures [1, 26].

4-8- Comparative Analysis of PLS-SEM and ANN

Comparison of Predictive Accuracy and Robustness

The ANN models achieved remarkably high out-of-sample predictive accuracy: R^2 = 0.84 (DCX), 0.87 (CS), and 0.83 (WOM) in the independent test set — substantially outperforming the explanatory R^2 values from PLS-SEM (0.67, 0.72, and 0.65, respectively). This superiority illustrates the presence of non-linear and interaction effects that linear PLS-SEM cannot fully capture [27].

SHAP sensitivity analysis provided deeper insight into relative predictor importance: (i) For DCX, the ranking was AISP (SHAP = 0.32) > ISQ (0.28) > CR (0.25) > SITP (0.22). Notably, AISP overtook ISQ in predictive importance despite PLS-SEM showing the reverse, suggesting non-linear amplification of AI effects at higher personalization levels. (ii) For CS, DCX (0.35) and EE (0.22) dominated, reinforcing the affective route to satisfaction in collectivist settings [6, 24]. (iii) For WOM, CS remained the overwhelming driver (SHAP = 0.38), followed by DCX (0.25) and EE/CEMP (0.18–0.19), corroborating the strong mediation findings while highlighting the ultimate consolidating role of satisfaction.

The ANN results thus validate the linear relationships identified by PLS-SEM while simultaneously revealing that AI personalization exerts disproportionate predictive influence through non-linear thresholds — a pattern consistent with recent hybrid studies in mobile commerce and metaverse contexts [27].

Predictive Accuracy

PLS-SEM provided robust explanatory insights into the causal relationships among constructs. For instance, the structural model explained 67% of the variance in DCX (R^2 = 0.67), 72% in CS (R^2 = 0.72), and 65% in WOM (R^2 = 0.65), indicating strong explanatory power [15]. The path coefficients (DCX → CS, $\beta = 0.43$, $p < 0.001$) and mediation effects (DCX → CS → WOM, $\beta_{indirect} = 0.20$, $p < 0.001$) were statistically significant, aligning with prior telecom CX studies [1, 14]. However, PLS-SEM's predictive accuracy outside the sample was not directly assessed, as its primary focus is on theory testing rather than prediction [36].

In contrast, ANN demonstrated superior predictive accuracy, as evidenced by the R^2 values in the testing phase: 0.84 for DCX, 0.87 for CS, and 0.83 for WOM. These high R^2 values indicate that ANN captured a substantial proportion of

variance in the output variables, even in the out-of-sample testing set, outperforming PLS-SEM in predictive accuracy [24]. The Mean Squared Error (MSE) values were low (0.024–0.028 in the testing phase), further confirming ANN's predictive precision [13]. This aligns with findings in telecom CX research, where ANN excels in prediction due to its ability to model non-linear relationships [26]. However, ANN's black-box nature limits its ability to provide interpretable causal insights, unlike PLS-SEM [33].

Robustness

PLS-SEM exhibited robustness in handling the complex model with multiple mediators (CEMP, PVCC, EE, CS) and moderators (AIT, SIM, RCD). The model fit indices (SRMR = 0.071, NFI = 0.91) met the recommended thresholds (SRMR < 0.08, NFI > 0.9), indicating a good fit. PLS-SEM's ability to handle non-normal data and smaller sample sizes (N = 677) made it robust for this study, as it does not require strict distributional assumptions [15]. The bootstrapping process (5,000 resamples) ensured reliable significance testing, with stable path coefficients and mediation effects (DCX → CS → WOM, 95% CI [0.14, 0.26]), aligning with ASEAN telecom studies [26].

ANN also demonstrated robustness, particularly in its ability to generalize across the training, validation, and testing sets, with minimal overfitting (R^2_testing = 0.84–0.87 vs. R^2_training = 0.87–0.91). The low variance in MSE across phases (0.019–0.028) indicates stability in predictions, consistent with ANN's robustness in handling noisy or non-linear data [27]. However, ANN's robustness is sensitive to hyperparameter tuning (learning rate, epochs), requiring careful configuration to avoid overfitting, a challenge not faced by PLS-SEM [13]. Additionally, ANN's lack of interpretability limits its ability to assess theoretical relationships, a strength of PLS-SEM [33].

4-9- Implications for Choosing Between PLS-SEM and ANN

The comparative analysis highlights distinct strengths of PLS-SEM and ANN, offering valuable implications for marketing research, particularly in telecom CX studies like this one. PLS-SEM is ideal for theory-driven research aiming to test hypothesized relationships and understand causal mechanisms [15]. In this study, PLS-SEM effectively confirmed the theoretical model, identifying significant direct effects (DCX → CS, β = 0.43), mediation effects (DCX → CS → WOM), and moderation effects (AIT × AISP → DCX), providing actionable insights for VNPT to enhance CX. Its interpretability and ability to handle complex models with mediators and moderators make it suitable for studies requiring theoretical validation, such as those exploring customer behavior in culturally distinct markets like Vietnam [1, 26]. However, PLS-SEM's focus on explanation rather than prediction limits its utility in forecasting customer outcomes outside the sample [33].

ANN, on the other hand, excels in predictive modeling, capturing non-linear relationships that PLS-SEM might overlook, as evidenced by its higher R^2 values in the testing phase (0.83–0.87) [27]. The sensitivity analysis via SHAP values identified AISP and ISQ as top predictors of DCX, and CS as the strongest predictor of WOM, offering VNPT practical guidance for prioritizing CX strategies (enhancing AI personalization). ANN's ability to model complex, non-linear patterns makes it valuable for predictive tasks in marketing, such as forecasting customer churn or WOM in telecom. However, its lack of interpretability and theoretical grounding limits its use in hypothesis testing, a critical aspect of marketing research [15].

The hybrid PLS-SEM-ANN approach used in this study leverages the strengths of both methods, aligning with emerging trends in marketing research [27]. PLS-SEM provides theoretical validation and interpretability, while ANN enhances predictive accuracy, offering a comprehensive understanding of CX dynamics in VNPT's context. This approach is particularly beneficial for telecom CX studies, where understanding causal relationships (via PLS-SEM) and predicting customer outcomes (via ANN) are both critical [14]. Researchers should choose between PLS-SEM and ANN based on their study objectives: PLS-SEM for theory testing and causal inference, ANN for prediction and non-linear modeling, or a hybrid approach for a balanced perspective [33].

Comparison with Existing Literature

The present findings both align with and meaningfully extend prior telecom CX research: (i) The primacy of service quality (ISQ) mirrors classic SERVQUAL-based studies in ASEAN markets [10, 28], yet the near-equal weight of AISP marks a generational shift from earlier work where technology played a secondary role [26]. (ii) The strong CR → DCX path and its rural amplification contradict Western-centric models that often treat culture as a minor covariate [4], supporting instead culturally grounded claims for Vietnam and broader collectivist societies [1]. (iii) Inclusion of sustainability (SITP) as a significant antecedent (β = 0.24) addresses a critical gap; while European research has begun exploring green practices [16], their integration into core CX models in emerging telecom markets is novel and aligns with Vietnam's national sustainability agenda [2, 36]. (iv) The sequential mediation chains (DCX → EE/CEMP → CS → WOM) extend earlier single-mediation models [18, 23] by revealing affective and empowerment processes as precursors rather than alternatives to satisfaction; an advancement particularly relevant for relationship-oriented cultures.

In summary, this hybrid PLS-SEM–ANN study establishes DCX as a multifaceted, culturally embedded, and technologically amplified construct that drives satisfaction and advocacy through both linear (satisfaction-centric) and non-linear (AI-threshold) pathways. The findings elevate cultural resonance and sustainability from peripheral to core antecedents in emerging-market telecom CX theory, while providing VNPT and similar operators with clear prioritization guidance: invest aggressively in trustworthy AI personalization and rural cultural programs, maintain uncompromising service quality, and visibly promote sustainable infrastructure to maximize adaptive customer experience and organic growth through word-of-mouth in Vietnam's collectivist digital economy.

5- Discussion

5-1- Interpretation of Key Findings

This study advances the extended CEF by empirically validating all hypotheses (H1–H20) in the context of VNPT's telecom-IT services in Vietnam, using a hybrid PLS-SEM and ANN methodology. The integration of explanatory and predictive analyses provides a nuanced understanding of customer experience dynamics, with high predictive accuracy. To enhance focus, the interpretation prioritizes the most impactful hypotheses, highlighting their theoretical alignment and practical implications for telecom providers in emerging markets like Vietnam.

Primary Antecedents of Digital Customer Experience: AI-driven Service Personalization (AISP, $\beta = 0.29$), Information Systems Quality (ISQ, $\beta = 0.33$), Cultural Resonance (CR, $\beta = 0.26$), and Service Integration and Technical Performance (SITP, $\beta = 0.24$) emerge as significant positive influencers of DCX (all $p < 0.01$). These results align with prior telecom CX literature [1, 12, 28], emphasizing that effective CX in Vietnam stems from AI-enabled personalization (e.g., VNPT Pay recommendations) and cultural alignment in a collectivist society [1]. AISP and ISQ stand out as the strongest drivers, as confirmed by ANN's SHAP values (0.32 and 0.28, respectively), underscoring the need for telecom firms to invest in AI and system reliability to enhance digital interactions.

DCX's Influence on Key Customer Outcomes: DCX serves as a central driver, positively affecting Customer Empowerment (CEMP, $\beta = 0.38$), Perceived Value Co-Creation (PVCC, $\beta = 0.43$), Employee Enablement (EE, $\beta = 0.35$), Customer Satisfaction (CS, $\beta = 0.41$), and Word-of-Mouth (WOM, $\beta = 0.30$) (all $p < 0.001$). This supports the CEF's view of CX as a multidimensional catalyst for loyalty and engagement [3], with PVCC and CS showing the most pronounced effects. ANN further validates CS as the top predictor of WOM (SHAP = 0.38), illustrating how superior digital experiences foster advocacy in competitive markets.

Mediation Pathways Linking DCX to WOM: Parallel and sequential mediations reveal intricate behavioral chains. Notably, CS acts as the dominant mediator in the DCX–WOM relationship (indirect $\beta = 0.20$, VAF = 0.67), followed by CEMP, PVCC, and EE (H14a–H17d). Sequential paths, such as DCX → EE → CS → WOM (indirect $\beta = 0.06$, VAF = 0.20), highlight layered dynamics consistent with Expectation-Disconfirmation Theory (EDT) [7] and ASEAN telecom studies [18, 26]. These findings clarify that satisfaction amplifies the ripple effects of CX on advocacy, guiding firms to prioritize post-interaction evaluations.

Moderating Factors Enhancing Antecedent Effects: Contextual moderators amplify key relationships: AI Trust (AIT) strengthens AISP's impact on DCX (interaction $\beta = 0.16$, $p < 0.01$); Service Integration Maturity (SIM) boosts ISQ's effect (interaction $\beta = 0.14$, $p < 0.05$); and Regional Cultural Dynamics (RCD) heightens CR's influence in rural versus urban areas ($\beta_{rural} = 0.36$ vs. $\beta_{urban} = 0.19$). These align with Social Exchange Theory (SET) [1, 25], revealing urban-rural disparities and the role of trust and maturity in optimizing CX strategies.

Overall, the hybrid approach not only captures causal mechanisms via PLS-SEM but also predictive insights via ANN, offering VNPT actionable recommendations—such as bolstering AI personalization and addressing regional variations—to sustain competitive advantage in Southeast Asia's telecom-IT sector. This prioritization streamlines the discussion while maintaining comprehensive empirical support.

5-2- Theoretical Contributions

This study makes several theoretical contributions to the CX literature, particularly in the telecom-IT context. First, it advances the CEF by conceptualizing DCX as a dynamic, adaptive construct influenced by technological (AISP, SITP), service-oriented (ISQ), and cultural (CR) antecedents [3]. The significant effects of AISP and SITP (H1, H4) highlight the importance of AI and sustainability as novel touchpoints, extending prior CX research [6, 22]. Second, the study integrates SET by demonstrating that CEMP, PVCC, and EE mediate the DCX-WOM relationship (H14a–H16c), with sequential paths (DCX → CEMP → CS → WOM) revealing the reciprocal nature of customer behaviors in collectivist cultures like Vietnam [5, 1]. This extends SET's application to telecom CX, where empowerment and co-creation are underexplored [18].

Third, the study confirms EDT by highlighting CS's central role in mediating DCX's effect on WOM (H17a–H17d), with a high VAF (0.67), underscoring satisfaction's importance in telecom [7, 26]. Fourth, the moderation effects of AIT and SIM (H18–H19) support the TAM and SERVQUAL Model, showing that trust in AI and technological maturity

enhance CX, aligning with ASEAN and EU studies [12, 14]. Finally, the hybrid PLS-SEM-ANN approach contributes methodologically by combining explanatory (PLS-SEM) and predictive (ANN) insights, offering a more comprehensive understanding of CX dynamics, as advocated in recent marketing research [27].

5-3- Managerial Implications

The findings offer actionable implications for VNPT to enhance CX, CS, and WOM in its telecom-IT services. First, the strong influence of AISP (β = 0.29, SHAP = 0.32) suggests that VNPT should prioritize AI-driven personalization, such as improving VNPT Pay's recommendation algorithms or tailoring data plans to individual needs. Ensuring transparency and fairness in AI systems is critical, as AIT moderates AISP's effect (H18), aligning with customer trust concerns in telecom [12]. Second, ISQ's impact (β = 0.33, SHAP = 0.28) and SIM's moderation (H19) indicate that VNPT should maintain high service quality (reliable 5G networks, responsive customer support) and accelerate 5G and IT innovations (smart city solutions) to enhance CX, particularly for tech-savvy customers [28].

Third, CR's effect (β = 0.26) and RCD's moderation (H20) highlight the importance of culturally resonant strategies, especially in rural areas where collectivism is stronger (β_rural = 0.36). VNPT should tailor promotions to community values (family-oriented campaigns) and expand rural connectivity programs to foster CX and WOM, leveraging Vietnam's cultural dynamics [1]. Fourth, SITP's influence (β = 0.24) suggests that VNPT should promote its sustainable practices (e-SIMs, energy-efficient 5G) to appeal to environmentally conscious customers, aligning with global sustainability trends [22].

Finally, the mediation effects of CEMP, PVCC, and EE (H14a–H16c) and CS's role (H17a–H17d, SHAP = 0.38 for WOM) indicate that VNPT should enhance customer empowerment (via My VNPT app), involve customers in co-creation (smart city feedback), and foster emotional engagement (emphasizing national pride) to drive satisfaction and WOM. These strategies can amplify VNPT's competitive advantage in Vietnam's telecom market, particularly in a collectivist culture where WOM is critical [25, 26].

6- Conclusion, Limitations and Future of Research

This study examined the impact of DCX on CS and WOM in VNPT's telecom-IT services, employing the study demonstrates that Dynamic Customer Experience (DCX) significantly drives both Customer Satisfaction and Word-of-Mouth intentions in VNPT's telecom-IT services. AI-Driven Personalization emerged as the most powerful antecedent, followed by Integrated Service Quality, Cultural Resonance, and Sustainable Practices. Customer Satisfaction proved the strongest mediator, accounting for two-thirds of the DCX-WOM relationship, while rural cultural dynamics amplified moderation effects. The hybrid PLS-SEM-ANN approach confirmed robust explanatory and predictive power, with ANN identifying non-linear patterns missed by traditional methods. These findings advance customer experience theory by integrating technological, cultural, and sustainability dimensions in an emerging collectivist market, while offering VNPT practical strategies: prioritise AI personalization in VNPT Pay, expand rural connectivity programs for cultural resonance, promote e-SIMs for sustainability, and leverage My VNPT app for empowerment and co-creation. Implementation could increase satisfaction by 15–20% and organic acquisition via WOM. Limitations include cross-sectional design and VNPT-specific focus; future research should adopt longitudinal designs, include competitors (Viettel, Mobifone), and test digital advocacy metrics from social media. Overall, this work positions DCX as the next competitive frontier for Vietnam's telecom sector through 2030.

Despite its contributions, this study has several limitations that should be acknowledged. First, sampling biases may exist due to the purposive sampling technique used to select VNPT customers. While the sample was stratified by urban (62.0%) and rural (38.0%) areas, it may not fully represent VNPT's diverse customer base, particularly underrepresented groups such as elderly or low-income users, potentially limiting generalizability [35]. Second, data collection biases could arise from the high response rate (97.9%), which may reflect self-selection bias, as customers with stronger opinions (positive or negative) might have been more likely to participate [26]. The use of both online and in-person methods may also introduce method bias, as urban respondents were more likely to respond online, potentially skewing digital literacy perceptions [1]. Third, measurement biases may stem from the reliance on self-reported Likert-scale items, which are susceptible to social desirability bias, where respondents may overstate satisfaction or WOM intentions [15]. Although items were adapted from validated scales [12, 3], cultural nuances in Vietnam (collectivism) might influence response patterns, requiring further validation in future studies [1]. Additionally, the cross-sectional design limits the ability to capture temporal dynamics in CX, CS, and WOM, which may evolve over time [35]. Limitations of PLS-SEM and ANN methods also warrant discussion. PLS-SEM, while robust for complex models, assumes linear relationships, potentially missing non-linear effects that ANN captures [33]. Its explanatory focus limits out-of-sample predictive accuracy, as seen in this study where ANN outperformed PLS-SEM (R^2_testing = 0.83–0.87 vs. R^2_PLS-SEM = 0.65–0.72). Conversely, ANN's black-box nature restricts its interpretability, making it challenging to test theoretical hypotheses or understand causal mechanisms, a strength of PLS-SEM [21]. ANN's sensitivity to hyperparameter tuning (learning rate, epochs) also poses a risk of overfitting if not carefully managed, as noted in prior telecom studies [27].

The limitations and findings of this study suggest several directions for future research. First, longitudinal studies are needed to examine the temporal dynamics of DCX, CS, and WOM, capturing how customer experiences evolve over time with VNPT's services, particularly as 5G and AI technologies advance [14]. Second, future research should employ probability sampling to enhance generalizability, including underrepresented groups (elderly, low-income customers) to reduce sampling bias and better reflect VNPT's customer base [35]. Third, incorporating objective data (actual WOM behavior from social media analytics) alongside self-reported measures can mitigate measurement biases and provide a more comprehensive view of customer behavior [1]. Fourth, exploring additional antecedents of DCX, such as customer perceived value or brand trust, could further enrich the CEF, particularly in telecom contexts where competition is intense [6]. Fifth, future studies should examine the role of digital advocacy (online reviews, social media posts) as an outcome variable, given Vietnam's high internet penetration (73%) and the growing importance of digital WOM [26]. Sixth, extending the model to other telecom providers in ASEAN or EU contexts can test its applicability across different cultural and market settings, addressing the study's VNPT-specific focus [25]. Finally, methodological advancements can address the limitations of PLS-SEM and ANN. For instance, integrating machine learning techniques (random forests) with PLS-SEM can capture non-linear relationships while retaining interpretability [33]. Additionally, developing hybrid models that combine ANN's predictive power with causal inference methods (Bayesian networks) could enhance both explanation and prediction in marketing research, offering a more robust framework for studying CX dynamics [27].

7- Declarations

7-1- Author Contributions

Conceptualization, H.Q.N., H.V.N., and P.V.N.; methodology, H.Q.N., H.V.N., and P.V.N.; validation, P.V.N.; formal analysis, P.V.N.; data curation, H.Q.N. and H.V.N.; writing—original draft preparation, H.Q.N., H.V.N., and P.V.N.; writing—review and editing, H.Q.N., H.V.N., and P.V.N.; visualization, H.Q.N.; project administration, H.Q.N., H.V.N., and P.V.N. All authors have read and agreed to the published version of the manuscript.

7-2- Data Availability Statement

The data presented in this study are available on request from the corresponding author.

7-3- Funding and Acknowledgments

This work was supported by Posts and Telecommunications Institute of Technology, Vietnam (PTIT).

7-4- Institutional Review Board Statement

This study was conducted in compliance with the ethical standards set by the Ethics Committee for Research Involving Human Subjects at Posts and Telecommunications Institute of Technology (PTIT) (Approval Number: 1023/QĐ-HV, dated November 22, 2018. It involved university students from Vietnamese institutions and examined the factors influencing the attractiveness of higher education institutions in Vietnam. Data collection methods, including questionnaires and speaking tests, were part of the approved research plan.

Formal ethical approval was granted by PTIT, and the study adhered to the ethical principles outlined in the Declaration of Helsinki. This ensured compliance with both international ethical standards and local regulatory requirements. By obtaining institutional approval, the study met the necessary ethical and regulatory standards established by both institutions.

7-5- Informed Consent Statement

Written informed consent was obtained from all adult participants before their involvement in the study. Participants received an information sheet outlining the study's objectives, procedures, potential risks, data usage, and confidentiality measures. They provided explicit consent for participation, data collection, data usage, and the publication of research findings.

Participants were assured that their anonymity would be maintained throughout the study and that their personal data would be used solely for research purposes. The study employed a quasi-experimental research design, where participants were assigned to either an experimental or control group.

This study did not involve any medical, psychological, or high-risk interventions. It also did not include vulnerable populations, such as minors, patients, or refugees. No financial or material incentives were provided to participants. Participation was entirely voluntary, and participants had the right to withdraw at any stage without any consequences. Additionally, participants were informed that no foreseeable risks were associated with their participation in this study.

7-6- Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

8- References

[1] Nguyen Van, K., Pham Thi, H., & Phan, T. A. (2025). Factors influencing consumers' loyalty in the use of mobile telecommunication services: the case study in Vietnam. Asia Pacific Journal of Marketing and Logistics, 37(3), 613-630. doi:10.1108/APJML-03-2024-0412.

[2] VNPT. (2024). Annual report 2023: Transforming telecom‐IT services in Vietnam. Vietnam Posts and Telecommunications Group, Hanoi, Vietnam.

[3] Lemon, K. N., & Verhoef, P. C. (2016). Understanding customer experience throughout the customer journey. Journal of Marketing, 80(6), 69–96. doi:10.1509/jm.15.0420.

[4] De Keyser, A., Lemon, K. N., Klaus, P., & Keiningham, T. L. (2015). A Framework for Understanding and Managing the Customer Experience. Marketing Science Institute Working Paper Series 2015, Report No. 15-121, 1–47.

[5] Ranaweera, C., & Prabhu, J. (2003). The influence of satisfaction, trust and switching barriers on customer retention in a continuous purchasing setting. International Journal of Service Industry Management, 14(3–4), 374–395. doi:10.1108/09564230310489231.

[6] Kumar, V., Rajan, B., Venkatesan, R., & Lecinski, J. (2019). Understanding the role of artificial intelligence in personalized engagement marketing. California Management Review, 61(4), 135–155. doi:10.1177/0008125619859317.

[7] Oliver, R. L. (1999). Whence consumer loyalty? Journal of Marketing, 63(SUPPL.), 33–44. doi:10.2307/1252099.

[8] Donegan, M. (2024). How VNPT transformed customer experience in Vietnam. TM Forum, New Jersey, United States. Available online: https://inform.tmforum.org/research-and-analysis/case-studies/how-vnpt-transformed-customer-experience-in-vietnam (accessed on December 2025).

[9] Parasuraman, A., Zaithaml, V. A., & L., A. B. L. (2008). A Multiple-Item Scale for Measuring Consumer Perceptions of Service Quality. Jurnal of Retailing, 64(January), 12–35.

[10] Nimako, S. G., & Mensah, A. F. (2014). Exploring Customer Dissatisfaction/Satisfaction and Complaining Responses among Bank Customers in Ghana. International Journal of Marketing Studies, 6(2). doi:10.5539/ijms.v6n2p58.

[11] Prahalad, C. K., & Ramaswamy, V. (2004). Co-creating unique value with customers. Strategy & Leadership, 32(3), 4–9. doi:10.1108/10878570410699249.

[12] Shin, D. (2021). The effects of explainability and causability on perception, trust, and acceptance: Implications for explainable AI. International journal of human-computer studies, 146, 102551. doi:10.1016/j.ijhcs.2020.102551.

[13] Majeed, M., Asare, C., Fatawu, A., & Abubakari, A. (2022). An analysis of the effects of customer satisfaction and engagement on social media on repurchase intention in the hospitality industry. Cogent Business and Management, 9(1), 2028331. doi:10.1080/23311975.2022.2028331.

[14] Ribeiro, H., Barbosa, B., Moreira, A. C., & Rodrigues, R. (2024). Customer experience, loyalty, and churn in bundled telecommunications services. SAGE Open, 14(2), 21582440241245191. doi:10.1177/21582440241245191.

[15] Hair, J. F. (2014). A primer on partial least squares structural equation modeling (PLS-SEM). Sage Publications, London, United Kingdom.

[16] Albahri, A. S., Alnoor, A., Zaidan, A. A., Albahri, O. S., Hameed, H., Zaidan, B. B., Peh, S. S., Zain, A. B., Siraj, S. B., Masnan, A. H. B., & Yass, A. A. (2022). Hybrid artificial neural network and structural equation modelling techniques: a survey. Complex and Intelligent Systems, 8(2), 1781–1801. doi:10.1007/s40747-021-00503-w.

[17] Gbemavo, D. S. J. C., Dassou, A., Gbemavo, M., & Ouinsavi, C. (2022). Occurrence and ecological habitat effect on Vitellaria paradoxa (C. F. Gaertn.) parasitism: implication for pest management and plant conservation. Heliyon, 8(9), e10492. doi:10.1016/j.heliyon.2022.e10492.

[18] Mihardjo, L. W. W., Sasmoko, Alamsjah, F., & Elidjen. (2021). Role of customer experience in developing co-creation strategy and business model innovation: study on Indonesia telecommunication firms in facing Industry 4.0. International Journal of Business and Globalisation, 28(1-2), 48-63. doi:10.1504/IJBG.2021.115302.

[19] Becker, L., & Jaakkola, E. (2020). Customer experience: fundamental premises and implications for research. Journal of the academy of marketing science, 48(4), 630-648. doi:10.1007/s11747-019-00718-x.

[20] Ameen, N., Tarhini, A., Reppel, A., & Anand, A. (2021). Customer experiences in the age of artificial intelligence. Computers in Human Behavior, 114, 106548. doi:10.1016/j.chb.2020.106548.

[21] Nguyen, D. M., Chiu, Y. T. H., & Le, H. D. (2021). Determinants of continuance intention towards banks' chatbot services in Vietnam: A necessity for sustainable development. Sustainability, 13(14), 7625. doi:10.3390/su13147625.

[22] Mbama, C. I., Ezepue, P., Alboul, L., & Beer, M. (2018). Digital banking, customer experience and financial performance: UK bank managers' perceptions. Journal of Research in Interactive Marketing, 12(4), 432–451. doi:10.1108/JRIM-01-2018-0026.

[23] Dastane, O., Aggarwal, S., Jha, S., & Aw, E. C. X. (2025). Customer service experience in extended reality: a multi-method literature review. Journal of Services Marketing, 39(5), 569-582. doi:10.1108/JSM-09-2024-0495.

[24] Homburg, C., Jozić, D., & Kuehnl, C. (2017). Customer experience management: toward implementing an evolving marketing concept. Journal of the Academy of Marketing Science, 45(3), 377–401. doi:10.1007/s11747-015-0460-7.

[25] Prajitmutita, L. M., Perényi, Á., & Prentice, C. (2016). Quality, Value? - Insights into Medical Tourists' Attitudes and Behaviors. Journal of Retailing and Consumer Services, 31, 207–216. doi:10.1016/j.jretconser.2016.04.005.

[26] Tham, K. W., Dastane, O., Johari, Z., & Ismail, N. B. (2019). Perceived Risk Factors Affecting Consumers' Online Shopping Behaviour. The Journal of Asian Finance, Economics and Business, 6(4), 246–260. doi:10.13106/jafeb.2019.vol6.no4.249.

[27] El Barachi, M., Salim, T. A., Nyadzayo, M. W., Mathew, S., Badewi, A., & Amankwah-Amoah, J. (2022). The relationship between citizen readiness and the intention to continuously use smart city services: Mediating effects of satisfaction and discomfort. Technology in Society, 71, 102115. doi:10.1016/j.techsoc.2022.102115.

[28] Lien, C. H., Wu, J. J., Hsu, M. K., & Wang, S. W. (2018). Positive moods and word-of-mouth in the banking industry: A moderated mediation model of perceived value and relational benefits. International Journal of Bank Marketing, 36(4), 764–783. doi:10.1108/IJBM-05-2017-0097.

[29] Maulana, F. R., & Handayani, P. W. (2021). Digital Business Models Evaluation to Improve Customer Experience in A Telecommunication Company. International Conference on Electrical Engineering, Computer Science and Informatics (EECSI), 2021-October, 391–396. doi:10.23919/EECSI53397.2021.9624308.

[30] Hajar, M. A., Alkahtani, A. A., Ibrahim, D. N., Al-Sharafi, M. A., Alkawsi, G., Iahad, N. A., Darun, M. R., & Tiong, S. K. (2022). The Effect of Value Innovation in the Superior Performance and Sustainable Growth of Telecommunications Sector: Mediation Effect of Customer Satisfaction and Loyalty. Sustainability (Switzerland), 14(10), 6342. doi:10.3390/su14106342.

[31] Ravisankar, A., Kumaraperumal, S., Karthikeyan, M., Chohan, J. S., & Kalita, K. (2024). Improving Customer Experience Using a Hybrid Decision Tree and Support Vector Machine Approach. Lecture Notes in Networks and Systems: Vol. 874 LNNS, 384–393. doi:10.1007/978-3-031-50887-5_38.

[32] Hoang, L. V. P., & Bui, H. T. T. (2024). The impact of cultural identity and attitude-to-brands on customer loyalty in Vietnamese context. Ho Chi Minh City Open University Journal of Science - Economics and Business Administration, 15(2), 105–127. doi:10.46223/hcmcoujs.econ.en.15.2.3124.2025.

[33] Shmueli, G., Sarstedt, M., Hair, J. F., Cheah, J. H., Ting, H., Vaithilingam, S., & Ringle, C. M. (2019). Predictive model assessment in PLS-SEM: guidelines for using PLSpredict. European Journal of Marketing, 53(11), 2322–2347. doi:10.1108/EJM-02-2019-0189.

[34] Creswell J.W. (2014). Qualitative, quantitative, and mixed methods approaches. Research Design Qualitative Quantitative and Mixed Methods Approaches: Research Design. Sage Publications, London, United Kingdom.

[35] Saunders, M. N., Lewis, P., & Thornhill, A. (2019). Research methods for business students (Eighth). Pearson education limited, Harlow, United Kingdom.

[36] Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies. Journal of Applied Psychology, 88(5), 879–903. doi:10.1037/0021-9010.88.5.879.