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The Tech-Enabled Shopper Impacting a Phygital Retail Complex System Stimulated by Adaptive Retailers' Valorization of an Increasingly Complex E-Commerce

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Abstract: The rise of the experience economy, driven by disruptive technologies delivering innovative experiences, has transformed the interactions between tech-enabled shoppers and the phygital retail complex system. An important knowledge gap is addressed in our study by evaluating shoppers' perceptions of disruptive technologies and the adaptive challenges that retailers face in securing consistency within a highly complex e-commerce landscape shaped by transformative interactions. A quantitative analysis was carried out using structural equation modeling (SEM) and survey data from an international supermarket chain integrating physical and digital retail spaces. We propose a novel framework to explore how retailers can harness data-driven insights and disruptive technologies to optimize the phygital shopping experience and adapt to the shift from multichannel and omnichannel strategies to optichanneling, as well as respond to societal shifts, including the role of digital natives and the expanding influence of the metaverse. This framework integrates key principles such as emergence, feedback, and criticality. The research reveals key findings about transformative shopper experiences across phygital retail touchpoints that influence shoppers' perceptions and behaviors. Based on these identified key insights, as shoppers increasingly expect seamless interactions, the framework includes practical recommendations for retailers relating to several key areas, including leveraging the metaverse for refined shopper engagement.

Keywords: phygital retail complex system; disruptive technologies; e-commerce; retailers' enhanced capabilities; tech-enabled shopper; innovative experience

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1. Introduction

Many years ago, Morin [1] defined the paradigm of complexity by highlighting self-organization and emergence and provided a foundation for a better understanding of complex systems. Estrada [2] emphasized how systems become complex through transformative interactions, termed "Morinian interactions", ranging from economies to human behavior and AI-driven organizations. These complex systems rely on intricate interconnections [3]. Pennacchioli et al. [4] applied complexity in the retail market to analyze

supermarket chains, gain an understanding of shopper needs, and predict purchasing behavior. Madanchian [5] showed how emergent behaviors can enhance trend prediction and business management via data usage by evaluating complex systems in e-commerce. Several perspectives have therefore emerged. Burke et al. [6] highlighted data-driven digital ecosystems for supply chain visibility, while Avasant Research [7] pointed to real-time data communication between e-commerce systems and supply chain management (SCM), customer relationship management (CRM), and enterprise resource planning (ERP) systems. Deutsch [8] and related studies [9] looked at the complexity of human decision making and its implications for shopper behavior. Additionally, recent research highlighted the importance of aligning CX with technology [10,11] and pointed out the need for retailers to prioritize holistic customer experiences [12]. Currently, CX metrics remain inadequate in capturing metaverse-specific dimensions, despite the rise of metaverse platforms [13]. It is important to mention that immersive webstores having only visual control lag behind those that benefit from both visual and functional control. In addition, product category managers already involved in products' immersive presentations may benefit from adding functional control [14]. As customers interact frequently across multiple channels, obtaining 360-degree CX requires AI-driven memory integration [15]. AI is central to digital experience management as modern commerce solutions leverage AI for agility, personalization, and dynamic experiences [16]. Grewal et al. [17] urged for a deeper exploration of disruptive technologies' impacts on dynamic consumer behaviors and retailers. According to Dowling [18], "the demand perspective can lead to some novel descriptions of markets", but true learning organizations need to consider disruptive change without forgetting the past (p. 2). Purcarea [19] highlighted the historical importance of academia–business partnerships in addressing technological disruptions in retail, a perspective that was shared by recent leadership and value chain studies [20–22], being informed, and having an evolving mindset [23,24]. According to Anderson and Ostrom [25], our lives (as both humans and consumers) and well-being are fundamentally affected by services and service systems. Today, the evolving shoppers' behaviors and expectations are putting pressure on retailers to better connect shoppers through disruptive technologies and provide personalized real-time shopping journeys, managing shoppers' data correctly and ensuring shoppers' control over their data. Schlag, Rocchi, and Turnbull [26] called for responsible e-commerce practices. Within the deepening integration process between online and offline retail can be obtained an integrated layout of shopping considering the increasing loyalty to online shopping channels [27]. The growing integration of online and offline retail channels demands innovative approaches to enhancing shopper loyalty, including by leveraging various innovations' impact on e-commerce models [27–30].

Research Objectives. This study sets out to develop a model that evaluates how tech-enabled online shoppers, viewed as dynamic systems influenced by genetic and environmental factors, impact phygital retail's complex systems. Specifically, we investigate 1. the influence of valued product selection features on phygital shoppers' experiences and spending behavior; 2. the role of disruptive technologies, including the metaverse, in shaping e-commerce retail.

Considering the limited research on phygital market complexity, our study sets out to examine the nature of interactions that define phygital market behavior. We explore how retailers can leverage disruptive technologies to boost shopper engagement, improve CX, and enhance loyalty. Additionally, we evaluate whether the adaptive use of technologies like the metaverse influences retailers' data-driven decisions and enhances the overall phygital shopping experience.

Retailers face challenges in real-time data processing and quality management, considering the growing volume, velocity, and variability of retail data. Our research proposes a

structured framework that supports retailers in addressing these challenges by leveraging shopper data for co-creation and immersive participation. Our approach contributes to the literature through a deep understanding of phygital retail complexity and through offering practical solutions for improving CX and business outcomes.

By emphasizing the evolving partnership between shoppers and retailers, this study highlights key theoretical and managerial implications, offering insights into advancing phygital retail systems characterized by emergence, feedback, criticality, and nonlinearity.

2. An Extended Literature Review

In the context of a growing retail market, many studies have examined the key concepts mentioned earlier and their influence on trends as well as how retailers manage to adjust to shoppers' evolving needs. The objective is to improve the phygital experience through agile business models, advanced marketing technologies, data-driven culture, and real-time collaboration. The role of various studies in helping retailers to better understand tech-enabled online shopper behavior and build strong customer relationships—while ensuring a seamless phygital shopping experience—remains underexplored. Alongside addressing online shopping addiction, particularly in the context of e-commerce growth [31], it is essential to consider Frith and Frith's insights [32]: "Nature and culture work together to shape who we are. We are embedded in culture and are profoundly influenced by what those around us say and do. . . While genetic processes affecting the brain are increasingly understood, the influence of cultural environments on brain development remains complex and not fully explained, particularly in how shifts between prior experiences and new evidence impact brain processes". An intriguing question is whether cultural influences can extend their influence to unconscious processes, reflecting the complex interplay between nature and nurture. Similarly, Sporns [33] highlighted the brain's unique ability to generate creativity and connect information dynamically. This capacity allows the human nervous system, as part of a whole organism, to extend cognition into the world, shaping history, art, and culture—while remaining challenging to predict and control.

2.1. Innovatively Using Data, While Going About Reaching Optichanneling, and Leveraging Disruptive Technologies Based on Applying Analysis Techniques

Through its Product Data Coalition of Action (together with the other eight coalitions of action), the Consumer Goods Forum (CGF, the only CEO-led organization ensuring global manufacturers' and retailers' representation) accelerates change, focusing on innovatively utilizing data, at the confluence of data, sustainability, and supply chain transformation, and by leveraging the strategic implications of new technologies [34]. Rigorous studies [35–39] emphasized the importance of customer journey analytics, data fabric, context-driven analytics, AI models, and the need for trusted data sharing as a key business metric. To deliver and measure CX, as underlined by Treasure Data [40], the most valuable data source is social media. A company must differentiate between its perception of customers' needs and what customers need [41].

Boston Consulting Group's experience underlined the "What" (from the right strategy to a balance sheet improvement) and the "How" (from leaders' enablement to desired culture's driving) to ensure tech transformations' sustainment [42]. Berg, Nilsson, and Liljedal [43] demonstrated that technology plays a key role in shaping customer experience (CX) in both physical and digital stores. Meanwhile, Frank et al. [44] conducted a lab experiment in a virtual retail store, exploring the transition of phygital retailers toward the metaverse as the future of shopping. As also recently reconfirmed by Kotler et al. [45], we are in full transition from multichannel (focus on quantity) and omnichannel (focus on seamless integration of all available channels) strategies to optichanneling (optimization

of the available channels), consumers' phygital touchpoints, and their three-dimensional journey becoming the new targets for marketers. Given that mobile devices play an increasingly significant role in shoppers' decision making, there is growing interest in understanding consumers' flow dynamics in mobile shopping, how flow influences engagement with new technology environments [46–48], and how shopping experiences and retailer outcomes are influenced by customer motivations and varying mobile device usage [49]. Purcărea et al. [50] analyzed retailers' actions on the new patterns and behaviors considering consumers' perceptions of AI-enabled interactions within the context of the COVID-19 pandemic, while Brandtner et al. [51] showed that the impact of a crisis like COVID-19 on the customer end of retail supply chains can confirm a strong decline in consumer satisfaction.

In highlighting customers' preference for consistent experiences across online and offline channels, Gao et al. [52] addressed issues with omnichannel CX inconsistency. Yin et al. [53] found that elements such as integration, individualization, and interaction within omnichannel strategies are generally effective in retaining customers. These elements have a positive influence on brand experiences, which, in turn, encourage continued shopping in retailers' channels, with purchase behavior playing a moderating role. Riaz et al. [54] highlighted that omnichannel retailing improves the shopping experience throughout the buying journey by ensuring seamlessness, integration, and usability. Batat [55] differentiated between phygital retailing—an approach combining digital and physical experiences to provide both functional and emotional value—and omnichannel retailing, which focuses on connecting digital touchpoints for e-commerce purposes. Cui et al. [56] referred to the service-dominant logic (SDL) theory by underlining how firms can foster value co-creation behavior (VCB) through effective online and offline channel synergy, with brand involvement partially mediating this relationship. Additionally, Borden et al. [57] affirmed the role of authoritative virtualization in ensuring error management in contexts like e-commerce.

Tan et al. underlined the importance of managing both the potential benefits and risks of the metaverse, including concerns about information security and data privacy, as it becomes key for the future of retail ([58], Contribution 13—Is the future of retail in Metaverse? pp. 26–28). Weinberger [59], using a qualitative meta-synthesis approach, defined the metaverse as "an interconnected web of ubiquitous virtual worlds partly overlapping with and enhancing the physical world". Sectors such as marketing, healthcare, and education are influenced more and more by the metaverse, which leverages extended reality (ER), virtual reality (VR), and augmented reality (AR) technologies to blend physical and digital realities, therefore creating new societal challenges and opportunities [58]. Agarwal and Alathur [60] highlighted the impact of metaverse elements on digital transformation, while Wheeler [61] explored the emergence of a new economy driven by the metaverse and reliant on VR and AR technologies. Stăiculescu et al. [62] described the metaverse as an autopoietic entity within the context of converging social systems, pointing to opportunities for innovation and synergy in a digitally transformed world.

Batat [63] emphasized the importance of creating a seamless connection between physical and digital environments by establishing a continuum of consumer value. Based on his research, replicating all sensory dimensions in the metaverse is unnecessary, with positive effects primarily tied to sight and touch, achieved through ER technologies. According to Prashar and Prashar [64], attributes of metaverse platforms significantly influence fashion shoppers' purchase intentions, with personalization playing a key role in enhancing immersiveness. Research conducted by Mehrotra et al. [65] pointed to metaverse retailing's ability to transform marketing by enhancing customization and amplifying customer engagement and experiences.

As retail continues to adapt and reinvent itself, actionable strategies are needed to leverage disruptive technologies. This includes applying advanced analytics, developing practical insights, and ensuring real-time consistency and personalization in phygital retail [66–76].

2.2. The Complex Nature of the Shopper Brain and Phygital Market Behavior: Challenges for Business Management in Addressing Complex Problems

The transition from multichannel to omnichannel retailing has been extensively studied, providing valuable insights into how shoppers navigate and make purchasing decisions across different channels [77]. Several studies have examined omnichannel strategies' evolving role in enhancing customer engagement and delivering high-quality phygital experiences [78–84]. Banik [85] proposed five dimensions of customer involvement—risk importance, risk probability, sign, interest, and pleasure—that considerably impact engagement in phygital retail. Additionally, Banik referenced Purcarea [86], whose work explores how the smart phygital era is shaping the future of retail. Another study by Mele et al. [87] examined the complexities of the phygital customer journey, such as blended contexts, nonlinear paths, hybrid artifacts, and intertwined emotions, focusing on customer experiences and perceptions.

To adapt to these challenges successfully, businesses must rethink product offerings and prioritize lifetime loyalty in their customer acquisition strategies. This is achieved by exploring alternatives to shrinkflation, using global strategies, and using other innovative approaches. The ADAPT model was proposed by Hamdan et al. [88] as a tool to mitigate inflation risks for apparel retailers. However, in a world struggling with shrinkflation (reduced product sizes), skimpflation (reduced quality), "greenflation" (rising energy costs tied to renewable transitions), and stagflation (rising costs due to supply chain disruptions), customer experience (CX) performance has seen a considerable decline [89]. This contrasts sharply with the urgent need to deliver tech-enhanced CX [90] and to implement solutions for emerging challenges.

Paraphrasing Dixon and McKenna [91], it can be said that retailers need to pay attention to consumers' valuation challenges, lack of information, and uncertainty about outcomes. Roggeveen and Rosengren [92] underlined the importance of delivering appropriate experiences and strengthening customer connections by considering human experience. The role of the metaverse in boosting customer engagement and enabling conversational marketing at scale through connection, personalization, and innovation was emphasized in the work of Bieliai [93]. Liao, Hu, and Liu [94] examined the positive effects of channel brand trust and customer satisfaction on repeat patronage in omnichannel contexts, underlining the importance of a reciprocal offline-to-online (O2O) model. According to CB Insights [95], virtual try-on technology is already contributing to e-commerce retailers achieving modest success. However, while digital CX is driving profitability, e-commerce faces significant pressures, including inflation and last-mile delivery challenges, to maintain customer satisfaction [96]. Research carried out by Yeh et al. [97] revealed that the established advantages of online channels could positively influence offline channels at the belief level. In this dynamic landscape, retailers should consider the influence of Gen Z consumers, who are digital natives and significantly shape social commerce. Their contributions include incorporating AI into daily life, generating and consuming user-generated content (UGC), and driving e-commerce conversions [98–100]. It is worth mentioning some recent innovations, such as Walmart's collaboration with the Roblox immersive gaming platform, that illustrate how virtual e-commerce enables the purchase of physical goods [101,102].

Enhanced data granularity, which combines big data with person-level information, has become a priority [103]. A Klavio AI trends report for e-commerce marketers [104]

showed a growing interest in predictive analytics and AI-powered customer insights to personalize interactions and drive growth. Huang, Gao, and Gao [105] highlighted the role of the metaverse in value creation within the phygital market by connecting the metaverse to the adoption of new technologies in marketing and consumption. Furthermore, the evolving metaverse is reshaping digital interactions, with AI-driven threat detection and response processes ensuring safe and secure user experiences [106].

The literature on the topic of the transition from multichannel to omnichannel retailing focuses on improving customer engagement, delivering seamless phygital experiences, and addressing the complexities of modern shopper behavior. Research urges businesses to innovate to address challenges such as shrinkflation, skimpflation, "greenflation", and stagflation while prioritizing lifetime loyalty and tech-enhanced CX. Advanced analytics, predictive models, and real-time data are key to creating personalized customer experiences and driving growth while social media and big data integration are essential for understanding consumer preferences and optimizing the shopping journey. The emergence of the metaverse is highlighted in the literature, as it is reshaping the retail experience, leading to important innovations such as virtual try-ons, immersive gaming platforms, and AI-enhanced safety and security. The influence of Gen Z and digital natives is also underlined in the literature, as Gen Z consumers significantly shape social commerce, while their behaviors drive the adoption of AI, UGC, and immersive technologies. The research on the topic also underlines challenges that retailers must overcome, such as omnichannel CX inconsistency, last-mile delivery challenges, and the need for trusted data sharing. At the same time, there are opportunities for integrating technologies, such as AI-driven analytics and customer journey mapping, which will help to address emerging complexities and foster customer satisfaction.

The transformative interactions between tech-enabled shoppers and the phygital retail complex system across all touchpoints and micro-moments depend on data analytics building deeper shopper insights and enhancing their phygital shopping experience. Data quality improvement depends on a strong data governance strategy giving support to predictive analytics and ensuring actionable insights' generation.

3. Theoretical Framework

The theoretical framework underpinning this research aims to understand the evolving dynamics of phygital retail markets and incorporates concepts from consumer behavior theory, digital transformation, and systems thinking to address how retailers can adapt to and anticipate the needs of increasingly complex shopper ecosystems. Several key constructs have been derived from the theoretical and empirical literature:

- O (Online Shopper Impact): Represents the evolving behavior and expectations of online shoppers and their influence on the phygital retail environment.
- P (Phygital Retail Dynamics): Captures the impact of disruptive technologies, such as the metaverse and AI, on e-commerce and the integration of physical and digital retail spaces.
- R (Retail Features and Shopper Valuation): Focuses on the retail features that omnichannel shoppers value and their influence on the retail spending environment.
- E (Disruptive Technology Impact): Integrates the role of advanced technologies, including extended reality (ER) and predictive analytics, in transforming retail practices.
- D (Data Analytics in Retail Strategy): Underlines the role of data analytics in enhancing the phygital shopping experience and building deeper customer insights.

Structural equation modeling (SEM) is employed in this theoretical model to explore and validate the relationships between these constructs. The hypotheses emphasize the interconnectedness of three variables, namely O (Online Shopper Impact) and P (Phygital

Retail Dynamics), exogenous variables; R (Retail Features) and E (Disruptive Technology Impact), endogenous variables; and R (Retail Features) and E (Disruptive Technology Impact), and D (Data Analytics), moderating factors, that serve dual roles as exogenous and endogenous variables.

Insights from multiple theories have contributed to the above-mentioned theoretical framework, such as service-dominant logic (SDL), which explains value co-creation behavior facilitated by online and offline channel integration [56,107]; consumer behavior theories, which focus on the impact of shopping motivations, decision-making processes, and the interplay between digital and physical shopping experiences [108,109]; the technology adoption model, which analyzes how disruptive technologies, such as the metaverse and AI, influence consumer behavior and retailer strategies [110–115]; and cultural and cognitive interaction models, which address the impact of nature and nurture on consumer cognition and behavior, highlighting the cultural environment's role in shaping decision making [116–118].

This framework is aligned with the aim of our research to explore how retailers can harness data-driven insights and disruptive technologies to optimize the phygital shopping experience and adapt to the shift from multichannel and omnichannel strategies to optichanneling, as well as respond to societal shifts, including the role of digital natives like Gen Z and the expanding influence of the metaverse [13,44,119].

This theoretical framework enables a comprehensive analysis of the dynamic interplay between phygital retailing, disruptive technologies, and evolving shopper behaviors.

4. Hypothesis Development

Formulating hypotheses based on both theory and prior empirical evidence is recognized as a characteristic of prediction by human scientists, in contrast to prediction by AI scientists, whose characteristic is pattern recognition based on prior experimental data [120]. Our research hypotheses were developed by considering relevant existing evidence and reasons to upgrade the certainty of this evidence or to reconsider various ideas if guaranteed by new evidence, after identifying knowledge gaps requiring further research (the literature review and our own prior work, as well as the relevant practitioner experience); using reasoning to deduce what will happen (forming the hypotheses and then testing the predictions accordingly) in our specific context of interest by identifying our problem of interest with regard to retailers' imperative to relentlessly adapt and reinvent themselves under the influence of disruptive technologies like the metaverse on e-commerce, while really capturing deep phygital shoppers' insights, including in response to stressing factors; determining the significance of this problem (the extent to which these findings will be applicable to retail adaptation and reinvented business practice and the evolving consumer education within the complex context, where shoppers will benefit from our findings); by determining the feasibility of studying this specific challenge.

This research is based on six hypotheses. The construct "O" (the ever-evolving online shopper is impacting the Romanian phygital retail) is an exogenous variable and has a positive impact both on the construct "R" (retail features valued most by the omnichannel shoppers and impacting their spending environment)—hypothesis H1)—as well as on the construct "D" (data analytics' role in retailers struggling to improve the phygital shopping experience)—hypothesis H6. Also, a strictly exogenous variable is the construct "P", which has a positive influence both on the construct "R" (retail features valued most by the omnichannel shoppers and impacting their spending environment)—hypothesis H2)—and on the construct "E" (impact of disruptive technologies like the metaverse on e-commerce)—hypothesis H3. Construct "E" is an endogenous variable for construct "R"—hypothesis H4)—and an exogenous variable for construct "D"—hypothesis H5. Thus,

the constructs "R" and "E" represent moderating factors, being in turn exogenous and endogenous variables. The theoretical model is presented in Figure 1 below.

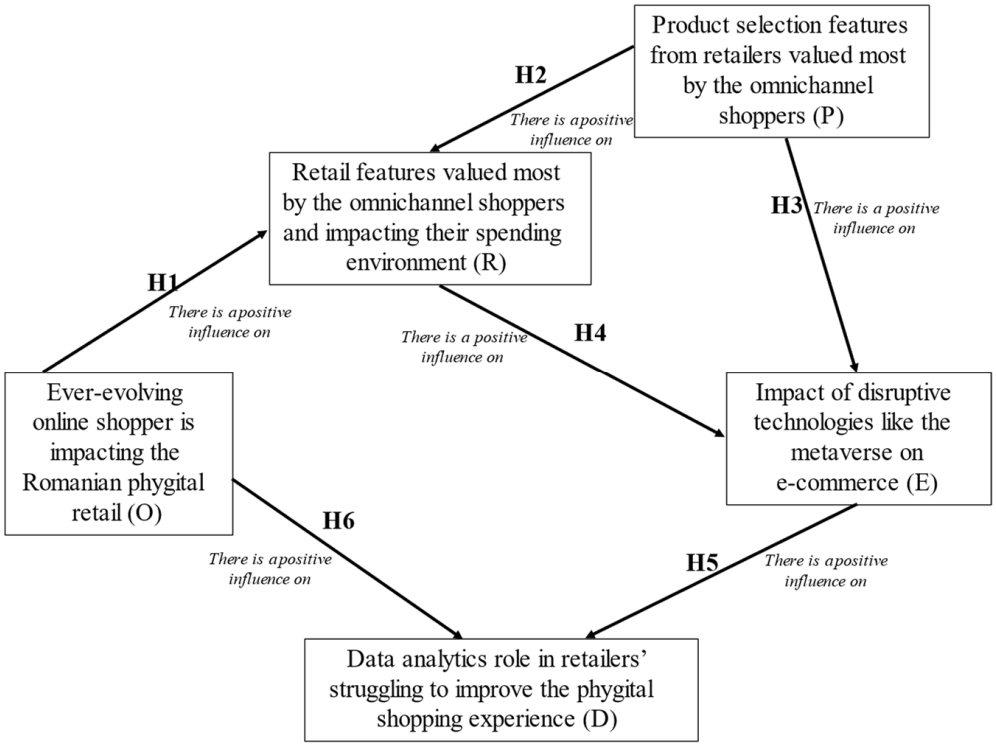


Figure 1. The theoretical research model (source: own research, based on the literature).

Starting from the theory of structural equation modeling (SEM), we designed a model in which we tried to validate the following hypotheses:

Hypothesis 1 (H1). *'The ever-evolving online shopper is impacting the Romanian phygital retail' (O) has a positive influence on 'Retail features valued most by the omnichannel shoppers and impacting their spending environment' (R) [50,82,83,86];*

Hypothesis 2 (H2). *'Product selection features from retailers valued most by the omnichannel shoppers' (P) has a positive influence on 'Retail features valued most by the omnichannel shoppers and impacting their spending environment' (R) [53,54,56,69,86];*

Hypothesis 3 (H3). *'Product selection features from retailers valued most by the omnichannel shoppers' (P) has a positive influence on 'Impact of disruptive technologies like the metaverse on e-commerce' (E) [17,58–64,69,74,80,84,86];*

Hypothesis 4 (H4). *'Retail features valued most by the omnichannel shoppers and impacting their spending environment' (R) has a positive influence on 'Impact of disruptive technologies like the metaverse on e-commerce' (E) [23,26,34,50,86];*

Hypothesis 5 (H5). *'Impact of disruptive technologies like the metaverse on e-commerce' (E) has a positive influence on 'Data analytics' role in retailers struggling to improve the phygital shopping experience' (D) [4,5,37,38,44,70,86];*

Hypothesis 6 (H6). *'The ever-evolving online shopper is impacting the Romanian phygital retail' (O) has a positive influence on 'Data analytics' role in retailers struggling to improve the phygital shopping experience' (D) [13,50,58,82,83,86].*

5. Research Methods

Starting from the qualitative research, we continued with the deployment of a quantitative study based on structural equation modeling—SEM [121–123]. In an attempt to obtain a valid instrument, we aimed to construct a questionnaire capable of measuring the variables. The data collection in this quantitative study was carried out through a survey conducted from May 30 to June 20, 2022 in a supermarket chain in Romania based on a questionnaire containing 15 questions aimed at building the profile of the respondents and a set of 37 closed-ended grid questions. The final number of those who answered all these questions amounted to 930, with an average response time of 10.30 min. Almost a third of respondents are aged 26–35, almost 30% are aged 36–45, and a quarter are aged 18–25. In the range of 46–65 years, we have a little over 11%, and for those under 18, we only have 2.37%, while the lowest representation is found in the over 65 category (under 1%). Among them, 41.51% are spending more than 2 h engaged with media and technology when they are online. A total of 28.71% spend between 1 and 2 h, 20.32% spend more than 3 h and 6.02% spend more than 6 h. Only 3.44% of consumers answered that they rarely or never stay online.

The sampling methodology was a random one: a mixture between the systematic approach (every 20th person) and the stratified approach (gender structures). Thus, the study has high legitimacy for this well-defined group: "Customers from Romania who make their purchases physically in the stores of the chain of analyzed supermarkets, opened in the shopping complex (mall)". We discuss here an important degree of validity of the research tool, effective from the point of view of the ever-evolving online shopper impacting the Romanian phygital retail market complex system, considering the evolving interactions. Participation in the study was voluntary and all conditions of confidentiality were respected. Respondents went through all the questions in the questionnaire. These questions helped us in acquiring a comprehensive understanding of the profile of our respondents as dynamical systems and guided us in the construction of the model. Considering both our own research and the review of the relevant literature in the field, we undertook a series of interviews with stakeholders (experts and clients) in order to generate the items. In the first phase, we generated a set of approximately 90 items. At the same time, we organized focus group interviews with relevant people from retail companies (10 people), specialists from important companies that own both online stores and classic/physical points of sale (10 people), online marketing specialists/retargeting/big data specialists (5 people), specialists in innovative technologies (5 people), and various retail clients (15 people). We managed to obtain an approximately equal gender distribution, and the age of the respondents was between 21 and 51 years, with a median of 35 years. We discussed with these groups the themes of the study and, together, we identified real-life examples that they faced. We were thus able to improve the applicability of the constructs and to observe certain new directions, which have not been presented up to this point in other studies. We generated an additional number of approximately 20 items, thus reaching a total of 110.

Following the steps specific to the construction of such a questionnaire, we used the face validity technique, calling on the successive feedback of two juries made up of university colleagues, successively eliminating more than 60 items and modifying about 30 other items. In the last phase, the authors performed a final review, assigning the most relevant items to each individual variable while ensuring that they accurately reflect the defined dimensions, respect the assumptions, and are also consistent. As a result, 37 items were retained, which were assigned a five-point Likert scale: (Yes, Partially true, Neutral, Rather not, and No), or (Strongly agree, Agree, Neither agree nor disagree, Disagree, and Strongly disagree). Before collecting the actual answers, we also conducted a pilot test with 25 respondents who provided additional feedback to the validity process. We thus

managed to increase the level of stability and internal consistency of the instrument, we reformulated a series of questions to improve the clarity of expression and shorten the questionnaire completion time. The reliability of the instrument was measured using Cronbach's alpha (its value was greater than 0.69 for each construct, thus being considered acceptable). The final form of the 37 questions is presented in Table A1 (Appendix A).

The reliability and validity of the measurement model were evaluated to ensure robust results for hypothesis testing. We verified both convergent and discriminant validity to confirm the internal structure and external distinctiveness of the constructs.

Table A5 (Appendix A) highlights critical metrics for assessing the validity and reliability of constructs. All constructs except for D meet the threshold for AVE ($\geq$0.5). However, D shows marginally acceptable results, with a composite reliability (CR) above 0.7, suggesting that it remains a useful construct for further analysis despite potential refinements needed for its associated items. The $\sqrt{}$AVE values along the diagonal indicate that each construct captures more variance from its items than from its correlations with other constructs (as $\sqrt{}$AVE > Max r). This confirms discriminant validity for the measurement model. The reliability and validity of the measurement model were evaluated to ensure robust results for hypothesis testing. This section outlines the steps taken to confirm the adequacy of the constructs.

To ensure that the constructs accurately capture the theoretical concepts, both convergent and discriminant validity were evaluated. These measures are critical in ensuring the reliability of the structural equation model and its underlying constructs. Convergent validity assesses whether items that are supposed to measure the same construct are highly correlated. It was assessed using average variance extracted (AVE). Each construct's AVE was calculated as the average squared loadings of its indicators divided by the number of items. An AVE value above 0.5 indicates that the construct captures sufficient variance from its indicators relative to error variance.

Table A5 presents the AVE values for all constructs, confirming that the majority exceeded the recommended threshold, except for construct D, which displayed marginal results. Constructs O, R, P, and E demonstrated adequate convergent validity, as their AVE values exceeded the threshold of 0.5. The construct D showed a lower AVE (0.497), which is slightly below the commonly accepted threshold of 0.5. However, this value is close enough to the threshold to suggest that the construct is not significantly compromised. Given its proximity to the threshold, the construct's validity may still be considered marginally acceptable, especially when coupled with its composite reliability (0.861), which exceeds the recommended 0.7 threshold. This approach aligns with the work of Fornell and Larcker [124], who noted that constructs with an AVE below 0.5 can still demonstrate adequate convergent validity if the CR exceeds 0.6. Future iterations of the survey instrument should focus on enhancing the clarity and relevance of items associated with this construct to ensure improved convergent validity.

Discriminant validity ensures that constructs are distinct from one another, capturing unique variances. Two key methods were used: the Fornell–Larcker criterion and heterotrait–monotrait ratio. The Fornell–Larcker criterion involves comparing the square root of each construct's AVE to the inter-construct correlations. The square root of AVE for all constructs was higher than the inter-construct correlations, confirming discriminant validity. HTMT ratios (heterotrait–monotrait ratios) were calculated and found to be below the 0.85 threshold for all construct pairs, further supporting discriminant validity.

6. Results and Discussions

The six hypotheses of the model, presented above, were verified through a survey based on the questionnaire method, considering the advancing phygital retail complex

system and the increasingly complex e-commerce, as well as the shopper brain complex system that brings change. The latent variables (O, P, R, E, and D), as well as the 37 items, are presented in detail in the above-mentioned Table A1, and the descriptive statistics are presented in Table A2 (Appendix A). In order to verify the validity of the model, several indicators were used, among which we mention the coefficient of determination, the standardized root mean squared residual, the root mean square error of approximation, the non-normed fit Tucker–Lewis index, the adjusted goodness of fit index, and the comparative fit index. For the numerical analysis part, we used two software packages: R 4.3.2 (together with R-Studio/2023.12.1+402) and the IBM product—SPSS Amos v.26.

The Latent Variables

"O" was evaluated on a Likert scale with five levels, between 1 (strong disagreement) and 5 (strong agreement). For this, the survey participants answered eight questions: O1–O8. The higher the values of each question, the greater the impact of the online shopper on the Romanian phygital retail. For these items, the lowest score was 3.10 for O4, which indicates a resistance regarding GPS location sharing. Thus, we can consider that an important part of shoppers wants an important level of privacy. The highest value of the standard deviation indicates, however, polarization regarding this situation—people who are strongly against and people who have no objection to sharing. The second lowest score was 3.14 for O8, indicating that opinions are divided with regard to the concept of live shopping. The highest scores were obtained for O1 (4.51) and O2 (4.44), thus confirming the strong impact of the COVID-19 pandemic on the online shopper. At a short distance, with a score of 4.35, is O7, which also confirms the hypothesis that technology can be useful to counteract the effects of bad periods from a macroeconomic point of view (inflation being one of the major concerns of macroeconomics).

"R" was evaluated through six questions, R1-R6, where we used a Likert scale with five levels ('1—Strongly agree' to '5—Strongly disagree'). The closer the average values are to 5, the more they indicate an increased impact on omnichannel shoppers' spending environment. The last question, R6, has different answers (I can name more than 3 companies, I can name at least 2 companies, I can name 1 company, I have heard about them but I cannot name any, I don't know), the higher scores indicating a better recognition of companies in the industry. The scores show relatively homogeneous values, between 3.71 and 3.93, an exception being the score obtained for R2 (4.11), which confirms the increased willingness of the online shoppers to improve their omnichannel experience.

"P" was evaluated through the definition of a construct with 10 items, these items being evaluated on a Likert scale with five levels (Yes, Partially true, Neutral, Rather no, No). For this construct, we have the highest average values: between 4.03 for P4 ('As a shopper, do you think that product selection is an important category of retail features?') and 4.54 for P1 ('Taking into account the overall increase in prices (utilities, fuels, foodstuffs), do you have a more pronounced orientation towards discount stores?'). It also represents the narrowest range of values among all constructs, as well as the lowest values of standard deviations, i.e., an increased homogeneity of respondents' opinions. It is confirmed once again that, in a difficult period, when consumer income and real value for money are affected, there is an increased focus on quality products offered at special prices. We are living at a time where private labels and discount stores show significant growth perspectives.

"E" was also evaluated on a Likert scale with five levels: Yes, Partially true, Neutral, Rather no, and No. Respondents were able to answer six questions, E1-E6, and, as a way of interpretation, the higher values indicate a higher impact of the disruptive technologies on the increasingly complex e-commerce. The highest value was 4.15 for E1 ('Do you think

that COVID-19 pandemic activated shifts in your online shopping behavior likely to have lasting effects?'), an aspect that indicates the long-term effects of the last few years in which we have witnessed some generalized lockdowns. We also observe a high value (4.11) for E4, which indicates high expectations from metaverse technologies. Although over 3, the lowest mean (3.52) is obtained for E6 ('Do you think, for instance, that the improvement of social buying capabilities (like recommendation engines, in-app buying, livestreaming, shoppable content etc.) motivate you more to shop and buy?'), suggesting realism about the economic situation, which does not allow shoppers to spend more, although that is probably what they would like to carry out.

"D" was evaluated through the definition of a construct with seven items, these items being evaluated on a Likert scale with five levels: Yes, Partially true, Neutral, Rather no, and No. The higher values indicate a more important role of data analytics in improving the phygital shopping experience. The lowest scores were 2,62 for D1 and 2.97 for D7. We thus observe shoppers' relatively low willingness to share private data in order to improve companies' algorithms. Although they are aware of the benefits of synchronizing personal data, an important part of shoppers believe that the biggest benefit would be taken over by the companies themselves, this aspect being indicated by the relatively high score obtained for D2 (4.36). For this construct, we have the largest range between item means, the maximum height being reached for D5 (4.46). Customers thus recognize the attractiveness of custom content created by companies.

Many authors mention several methods for measuring internal consistency reliability, among which we can mention Omega [125], greatest lower bound (GLB) [126], GLB.fa, GLB.a [127], or Cronbach's alpha [128]. The latter, which is also the most used, takes into account the number of items and the average inter-item covariance among the items, as well as the average variance. Opinions are divided on the accepted values for Cronbach's alpha; however, we can draw a conclusion that high values, close to 1, are considered as very good, while a lower threshold around 0.7 is considered as acceptable. It is advisable to view the scores with reservation if there are latent variables with too many items or if there are redundant questions. The design of the questionnaire entitles us to look with confidence at the values obtained for Cronbach's alpha indices, presented in Table A3 (Appendix A).

We note, on the one hand, a value of 0.921 (excellent) obtained for the construct P ('Product selection features from retailers valued most by the omnichannel shoppers'), as well as 0.815 for the construct R ('Retail features valued most by the omnichannel shoppers and impacting their spending environment') (A). We also recorded acceptable values for E ('Impact of disruptive technologies like the metaverse on e-commerce') (0.792) and for O ('Ever-evolving online shopper is impacting the Romanian phygital retail') (0.774). The only construct that raises questions, but is still very close to the lower limit of acceptability, is construct D ('Data analytics role in retailers' struggling to improve the phygital shopping experience'), with a value of 0.694.

For these calculations, we used R-Studio, specifically the "ltm" and "DescTools" packages, respectively [129]. To generate the model, shown in Figure 2, we used the Amos software package of the IBM group (Armonk, NY, USA).

In the specialized literature, it is recommended that the factor loading values exceed a threshold of 0.7 but, often in practice, the threshold value can be low, though not lower than 0.5. Most coefficients (30) meet the most restrictive criterion, 4 of them have values in the range (0.6, 0.7), and only 3 coefficients are found in the range (0.5, 0.6).

Five of the six working hypotheses are validated because the p-value is less than 5%. There is a direct link between O ('Ever-evolving online shopper is impacting the Romanian phygital retail') and D ('Data analytics role in retailers' struggling to improve the phygital

shopping experience'), but the associated risk is approximately 15%. The output, also generated with the help of the Amos package, is presented in Table A4 (Appendix A).

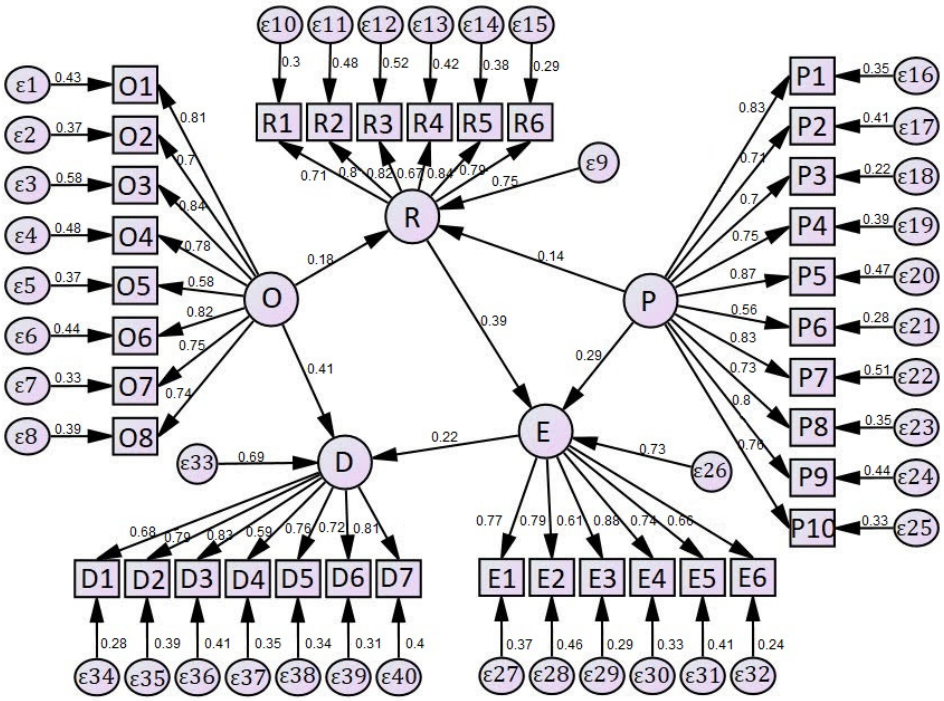


Figure 2. The structural model.

The hypotheses were tested only after confirming the validity and reliability of the measurement model. Hypotheses H1, H2, H3, H4, and H5 were validated, indicating significant relationships among the constructs.

H1. The results confirm that the ever-evolving online shopper significantly impacts retail features valued by omnichannel shoppers. This supports the existing literature emphasizing the transformation of consumer shopping behavior in phygital environments. H2. Product selection features significantly influence retail features valued most by omnichannel shoppers. This aligns with findings highlighting the critical role of product differentiation in customer engagement. H3. Product selection features also positively impact the perceived role of disruptive technologies in e-commerce, supporting theories on the interaction between product attributes and technological adaptation. H4. Retail features valued most by shoppers directly impact the perceived role of disruptive technologies, reinforcing the importance of consumer-centric strategies in phygital retail systems. H5. Disruptive technologies play a significant role in influencing the adoption of data analytics in improving phygital shopping experiences.

Hypothesis H6 was not supported (p-value = 0.145), suggesting that the direct relationship between O and D requires further investigation. However, this result does not undermine the overall robustness of the model. The relatively high path coefficient ($\beta = 0.407$) indicates a meaningful, though not statistically significant, relationship, highlighting a nuanced interaction that may involve indirect pathways through other constructs, such as E (impact of disruptive technologies). This aligns with the prior literature suggesting that analytics-driven improvements often rely on intermediary influences [55]. While there is a 15% risk that this direct relationship is spurious under the current model, the findings open a promising avenue for exploring mediating variables or additional contextual factors that may better capture the dynamics between O and D.

Finally, the accuracy of the model was evaluated. The obtained values forced us to rebuild the model several times. We will only discuss the results obtained in the last

iteration. The amount of variance that can be explained by the proposed model can be approximated with the help of absolute fit indices, among which we would mention a chi-square (which we want to be as small as possible, but which can be affected by the sample size) and adjusted goodness-of-fit index. It is also aimed at obtaining a *p*-value greater than 5%, a fulfilled aspect, corroborated with a relatively large sample size, indicating a good model. The ratio between the chi-square and degrees of freedom (CMIN/DF = 2.427) is significantly lower than 3, so we can say that the model is suitable for the covariance matrix.

Next, we compared the constructed model with a reference model using incremental fit indices. And, in this case, we obtained recommended values above 90% for the normed fit index (NFI), comparative fit indices (CFIs), and Tucker–Lewis index (TLI), as well as for the relative fit index (RFI), i.e., a good fit. Last but not least, we analyzed the differences between the observed covariances and the estimated variants with the help of residual-based fit indices. The confidence interval does not pass through the origin and the root mean square error of approximation (RMSEA) = 0.041, denoting a well-fitting model.

7. Key Findings and Recommendations

The findings of our research provide valuable insights into the existing body of studies. Our results underline the focused nature of interview responses. Direct websites were identified by nearly two-thirds of respondents as the most influential channel for driving customer engagement and online sales, while just over one-third of respondents preferred social media platforms. The ease of finding products was identified as the most valued commercial capability that encourages purchase decisions (42%), followed by customer reviews (34.41%). Easy website navigation ranked lowest, with only 23.66% of respondents selecting it. A key insight is related to the way that online shopping journeys typically begin and what triggers the purchase process. Most shoppers (31.18%) start by using online search engines to identify products or sellers. This applies to all available search engines. In what concerns Romanian shoppers, the eMag platform ranks second as a preferred starting point, even if shoppers do not always complete their purchase on this site. In the next places in consumer preferences are two sites (applications) of the company Meta: Facebook (15.05%) and Instagram (8.06%). We have to mention here that, together, the two percentages would exceed the score obtained by eMag, thus confirming the increased monetization of the company's applications. Next, we find YouTube (5.27%), which belongs to Google. TikTok, the preferred choice by younger people, obtains a score of only 3.55%, while the rest of the social media platforms together do not exceed 3.44%. Other retailer sites add up to 10%. The largest aggregator worldwide, Amazon, does not appear in Romanians' preferences for this activity; only 3% of respondents start their search on this company's website.

Some of the earlier findings are supported by consumers' choices of the most trusted social media platforms for shopping. Meta leads the list, with Facebook (37.31%) and Instagram (16.77%) as top preferences. YouTube, owned by Google, comes in second with 22.8%, followed by Pinterest at 11.29%. TikTok ranks lower at 4.95%, LinkedIn at 2.37% (mainly used for professional networking), and Twitter, which is less popular in Romania, is last with under 1%. Other unnamed platforms account for a combined 3.55%.

The results of our research point to new insights into how useful social media platforms are for shoppers. When asked a question allowing for multiple answers, 44.09% of consumers mentioned that they use social media to collect shopping information, while 39.35% use it for inspiration. Over one-third follow influencers and consider their advice, but only 12.9% are influenced by recommendations from trusted friends or family. Additionally, just over a quarter of shoppers stay informed through frequently updated content.

Consumers highlighted several preferences and factors influencing their buying decisions when asked about retail features that they value most as omnichannel shoppers. The majority (55.91%) value free membership programs, followed by click-and-collect or buy-online-pickup-in-store services (42.47%). Virtual try-ons are favored by about one-third of respondents, while only 14.84% prefer the option to buy online and return in store. Curbside pickup, which is less common in Romania, scored the lowest at 4.73%. Price and savings also play an important role, with two-thirds of shoppers influenced by great deals, discounts, and money-saving coupons, helping them to manage rising costs. Quick and convenient shopping is important to 61.29% of consumers, while only 35% show strong brand loyalty. Other factors, not specifically mentioned, account for 15.48%. These findings suggest a strong tendency for consumers to prioritize savings during economic challenges.

Our research provided interesting insights into the product categories where consumers would spend less due to inflation and economic challenges. Groceries ranked first, with 20% of respondents cutting back their spending in this category, followed by personal care products (15.48%) and footwear (11.94%). Alcohol and cigarettes were less likely to see reduced spending, with only 8.49% of respondents willing to cut costs there. Footwear was at the bottom of the list, at 7.42%. Other unspecified product categories accounted for a significant share, totaling 36.67%.

Another encouraging finding underlines shoppers' interest in sustainability and health-related benefits when choosing products from retailers. About 45.27% of consumers appreciate descriptive tags and filtering options for environmentally sustainable products. Additionally, 34.84% support and appreciate locally sourced products and their related benefits. However, only 17.74% of respondents prioritize products with sustainable packaging.

Another interesting finding, based on a question allowing multiple answers, examines the customer experiences that consumers expect from a metaverse environment. The majority (62.8%) are interested in shopping or browsing clothing and accessories, drawn by immersive experiences that reduce uncertainty and enhance engagement. Additionally, 45.27% are keen on planning trips and vacations, while 40.32% look forward to browsing skincare, makeup, beauty, and grooming products. Health-related interests also stand out, with 35.05% seeking fitness and exercise routines and 26.88% looking for health and wellness information. In the food category, 32.8% expect better options for ordering food delivery, 28.92% want to find convenient restaurants, and 23.12% are interested in browsing groceries. Considering the context of lending slowing and interest rates rising, only 12.8% express interest in shopping or browsing real estate. Other unmentioned experiences are anticipated by 38.06% of consumers.

Our study also presents important challenges that retailers face regarding customer data. Understanding customer behavior across hybrid (physical and digital) marketing channels is seen as the biggest challenge by 39.14% of respondents. Other issues include poor data integrity (35.05%) and integrating data from diverse sources (30.86%). Additional difficulties include turning insights into actionable strategies (28.82%), dealing with internal legacy systems (28.49%), identifying customers across multiple business lines (27.53%), and managing data silos (24.19%). Finding relevant customer data insights (20%) is another concern. Lesser priorities are managing customer data ethically without stifling innovation (13.44%) and protecting sensitive customer data (10.11%), reflecting a lack of trust in IT companies' ethical standards.

When asked about the importance of voice of the customer (VoC) feedback practices, 46.88% emphasized listening to customers and improving customer experiences through better behavior insights. Another 36.45% underlined making it easier for shoppers to buy products, while 3.55% were unsure of the importance.

In another finding, 44.52% of respondents believe that promotions are the main factor influencing last-minute changes in shopping behavior, with one-third pointing to price and 18.17% considering value for money.

Finally, user-generated content plays a critical role in building consumer confidence online. The majority (61.08%) trust shopper reviews and ratings, followed by comprehensive product descriptions (42.37%) and shopper-generated photos (38.06%). Professional content is viewed with skepticism, as it is often perceived as paid advertising. Only 28.49% appreciate professional product videos, and just 16.77% trust professional product photos.

These are significant key findings about transformative shopper experiences across phygital retail touchpoints that influence shoppers' perceptions and behaviors. Based on these identified key findings, as shoppers increasingly expect seamless interactions, we make relevant recommendations for retailers relating to several key areas: *obtaining deeper insights into shopping journeys and the influencing factors* (given that 31.18% of shoppers start their purchase journey through search engines, retailers should invest in SEO and paid advertising strategies to capture early-stage interest), *improving shopper attraction by leveraging omnichannel features and optichannel* (free membership programs (55.91%) and click-and-collect or BOPIS services (42.47%) are highly appreciated; retailers should promote loyalty programs and ensure the integration of both online and in-store experiences), *optimizing sales channels and shopper engagement strategies* (direct websites are the most influential sales channels, preferred by two-thirds of respondents; retailers should focus on improving their website experience, ensuring that it is user-friendly and facilitates easy product discovery), *elevating online shopping experience* (consumers value product discovery tools, with 42% emphasizing the importance of ease in finding products; retailers should focus on intuitive search functions, comprehensive filtering, and clear categorization to improve product visibility), *placing sustainability as a differentiator* (almost half of respondents (45.27%) value filtering for environmentally sustainable products, and 34.84% prioritize locally sourced items; retailers should showcase sustainability features in product descriptions and adopt eco-friendly practices to appeal to environmentally conscious consumers), and *leveraging the metaverse for refined shopper engagement* (given that 62.8% of consumers show interest in browsing clothing and accessories in a virtual environment, retailers should progress in exploring immersive shopping experiences). And, advancing on this path (including by considering interoperability challenges regarding ensuring continuous CX), it is important to focus attention on the evolving phygital shopping behaviors (interactions in touchpoints and micro-moments, preferences, expectations for personalized and appealing interactions, and purchasing patterns) impacted by digital innovation. Consequently, retailers need to adopt the right marketing strategies based on valuable insights into these behaviors so as to increase loyalty and attachment, by aligning offers with individual preferences. Also, they need to continuously refine their marketing strategies in the metaverse by using new metrics for evaluating the success obtained in delivering experiences on these evolving phygital shopping behaviors' terms.

8. Conclusions and Implications

There is a key challenge that retail business management faces in transforming performance while navigating an increasingly complex retail market system that has become central to shoppers' lives. This transformation needs clear goal setting and alignment with emerging trends and technologies to anticipate and capitalize on change. It also involves improving marketing planning and capabilities to deliver value while innovating and strategizing effectively. Retailers are key players in the supply chain and must take full responsibility for understanding the interplay between a solution-driven, innovative retail culture and the evolving complexities of shopper psychology. Transformative CX across

touchpoints, including micro-moments and real-time interactions, influence shoppers' perceptions and behaviors.

The findings of this study confirm the validity and reliability of the constructs, aligning with best practices in SEM analysis and adding to the body of knowledge in phygital retail systems. This study's findings align with prior research on the critical role of validity and reliability in SEM-based analyses [119]. The validation of most hypotheses corroborates the existing literature on consumer behavior in phygital retail environments. However, the marginal results for construct D suggest potential challenges in measuring the role of data analytics in improving phygital shopping experiences. This aligns with studies highlighting consumer skepticism toward data-sharing practices [55].

Our study offers valuable insights for scholars examining the relationship between retailers' operational customer engagement strategies and consumer decision making within the context of real-time interactions in the complex retail market system. Retail business management is facing a growing challenge of capturing tech-savvy shoppers' attention while delivering seamless phygital shopping experiences. Today's shoppers rapidly adopt new technologies and favor omnichannel and phygital interactions, personalized end-to-end (E2E) shopping experiences, a wider range of choices, and enhanced trust. Retailers must make use of accurate data insights to be able to understand shoppers across their journeys and leverage advancements in disruptive technologies. These technologies, including the metaverse, can transform shopping into a more immersive, enriching experience that fosters greater engagement and trust with tech-enabled consumers.

8.1. Theoretical Implications

The findings contribute to advancing knowledge by addressing critical questions about the transformative dynamics of the phygital retail market complex system. Specifically, the research highlights the importance of the following:

1. Facilitating product discovery and delivering meaningful interactions with the help of technologies like the metaverse, which digitizes real-life retail experiences.
2. Addressing the challenge of increasing shopper engagement and retention by accelerating digital and technology-driven initiatives to deliver immersive experiences that meet or exceed expectations.

The design of our study fills knowledge gaps in terms of understanding the interplay between disruptive technologies, data analytics, and interoperability in the retail market. It also underlines the impact of economic pressures, such as inflation, on shopper behavior, including the increased preference for lower prices compared to planned purchases. The insights provided are particularly relevant in today's volatile, uncertain, complex, and ambiguous (VUCA) environment, where retailers face increasing challenges in managing costs and maintaining sales while meeting evolving shopper expectations. This study contributes to the literature by validating a robust framework for analyzing the impact of tech-enabled shoppers on phygital retail systems. The findings underscore the importance of comprehensive measurement model assessments in quantitative research.

8.2. Managerial Implications

The findings of our research underline the pressing need for retailers to adopt systemic thinking and proactive strategies in business management. This includes fostering innovation capabilities, leveraging retailer–academic collaborations, and accelerating the effective implementation of digital and technology initiatives. Critical steps toward achieving success in phygital retail include achieving seamless omnichannel interactions, upgrading e-commerce capabilities, and focusing on e-customer satisfaction—measured through feedback from complaints, comments, and reviews. Retailers must rethink and invest in supply

chain capabilities, analytics, automation, educational content (including business–academic partnerships as agents of change), expertise in shoppable livestreams, and delivery experience management technologies to meet the growing demands of e-commerce fulfillment. Retailers should prioritize the seamless integration of data analytics tools to enhance the phygital shopping experience. Efforts should be made to address consumer concerns about privacy to improve data-sharing willingness. At the same time, efforts should be made to raise shopper awareness of new goods and services offered.

In today's competitive landscape, it is imperative that retailers embed a clear vision of social impact into their business models by adopting disruptive technologies, improving social interactions, and creating convenience for shoppers, given the huge challenges of addressing shoppers' social needs within an ESG (environmental, social, and governance) framework. Retailers are better equipped to navigate the pressures faced if they engage customers in innovative ways and further improve the quality of their experiences.

This research integrates both insider and outsider perspectives, striking a balance between objectivity (external perceptions) and sensitivity (empathy for uncertainties' impact). This ensures a deeper understanding of the challenges and opportunities, enabling informed strategies that address the complexities of modern retail.

8.3. Limitations and Further Research

This study presents several limitations that should be acknowledged and addressed in future research to enhance the generalizability and applicability of the findings.

Demographic Skew Towards Younger Respondents. The study sample includes only 12% of respondents aged over 45, with less than 5% over 55. This skew provides some limitations in the insights into the behaviors and preferences of older consumers, who may display different shopping habits, levels of technological adoption, and responses to emerging retail trends. Additionally, given that younger respondents dominate the sample—26–35 years (31%), 36–45 years (29%), and 18–25 years (25%)—it does not represent the broader consumer base in Romania or globally. Future studies should consider a more balanced age distribution, for example, by adopting targeted outreach strategies or incentivizing participation from older age groups.

Focus on a Single Region (Romania). The study focuses on Romanian-speaking participants, which, although providing valuable insights into Romanian tech-enabled shoppers, restricts its applicability to other regions. Cultural, economic, and technological contexts can vary significantly across countries, especially in Eastern Europe. Future research should include comparative studies across multiple regions within the European Union or globally. Expanding the research to integrate diverse geographies will help to point out commonalities and differences in shopper behavior, contributing to a richer theoretical framework.

Additionally, future studies should revisit construct D to refine its associated measurement items. Leveraging additional methods such as exploratory factor analysis during the development phase may help to improve the construct's AVE, ensuring that it meets or exceeds the 0.5 threshold. Future research should explore this relationship (H6) further by incorporating mediating or moderating variables, such as technological adoption levels or organizational readiness. Additionally, qualitative studies could provide deeper insights into the contextual factors affecting this relationship, particularly in phygital retail environments.

Building upon the findings of the present research and reassessing and expanding the theory and framework addressed in this paper, further research will be carried out and conducted about the advancing relation between tech-enabled shoppers, disruptive technologies, increasingly complex e-commerce retail, and its subset m-commerce, whose

future is impacted by mobile shopping apps (including the increasing role of digital wallets as a substratum for these apps). To leverage mobile engagement effectively, we seek to differentiate between purchases made on mobile devices and instances where mobile browsers abandon carts. This involves using mobile apps as tools for relationship building to improve the user experience and drive shopper loyalty by integrating practical strategies with advanced technology solutions.

The focus shifts to today's digital center of CX, considering the transformative potential of AI, including GenAI integrations, the evolving shopper responses to AI implementations, and the progress in shaping shoppers' perceptions. As shown earlier, mobile apps play a fundamental role in this context, with emerging trends such as transitioning from mobile devices to wearables. We also observe a high interest from retailers in marketplaces, retail media, and social commerce, which are key to advancing shopper–retailer partnerships grounded in knowledge co-creation.

In this context, the academic community plays a crucial role in building successful retailer–academic collaborations to develop innovative models. These models will allow one to examine how a phygital retail complex system is impacted by a tech-enabled online shopper as a dynamical system influenced by both genetic (nature) and environmental (nurture) factors. These types of collaborations will help one to develop a better understanding of shoppers' diverse perceptions and evolving experiences, which leads to organizational cultural shifts that are necessary to drive actionable insights and innovation.

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Data Availability Statement: The original contributions presented in the study are included in the article; further inquiries can be directed to the corresponding author.

Conflicts of Interest: The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Appendix A

Table A1. The latent variables and related items.

Ever-evolving online shopper is impacting the Romanian phygital retail (O)	O1	Do you think that your online shopping priorities (channel preferences, payment methods, personal connection etc.) have evolved during the last 3 years?
	O2	Comparing to 2019, do you spend more time online per day thinking about shopping on channels, platforms?
	O3	Do you think that playable shopping (using game-like techniques to motivate you towards a behavior the business targets and offer you rewards like a discount code for downloading its app or completing a challenge for your voluntary participation in an exclusive sale) is creating additional value for your ongoing customer engagement?
	O4	Do you like to receive mobile promotions in real-time (regarding local products, inventory search etc.) when you are near a supermarket chain?
	O5	Are you willing to make routine grocery purchases when you are offered auto-replenishment by retailers' ecommerce platforms (turning to retailers' subscription services) being motivated by savings, meal-types, ingredients, or seasonal items?

Table A1. *Cont.*

Ever-evolving online shopper is impacting the Romanian phygital retail (O)	O6	As a consumer, could you say that your value perceptions (e-commerce store image, product quality, price, service quality, innovation) derived from online shopping may facilitate your purchase intention beyond the online channel context?
	O7	As a consumer impacted by inflation, are you more likely to increase the use of digital price comparison and coupon tracking tools?
	O8	Do you agree with the opinion that live shopping is now in vogue as livestream shopping (its digital version) is considered the main accepted trend in e-commerce?
Retail features valued most by the omnichannel shoppers and impacting their spending environment (R)	R1	As a shopper, do you like to combine offline channels (shopping in brick-and-mortar stores) and online channels (shopping from a desktop or mobile device, by smartphone or tablet) throughout your buyer journey, connecting your in-store experience with your digital shopping one?
	R2	Are you interested in improving your omnichannel experience (as a result of your increasing interaction with e-commerce stores, social selling, mobile applications, digital marketplaces), so as to be provided with a seamless shopping experience?
	R3	Do you feel understood, heard, and observed by retailers as shopper?
	R4	Do brands reflect the values (like consistent customer experience—CX, a relatable marketing message, an authentic image) which are important to you?
	R5	Do you agree that now it's the right time for an improved brand-retailer collaboration regarding product, shopper, and data analytics?
	R6	Do you know an example of big technology company involved in omnichannel enablement leveraging technological advances to solve retail stores' functions and operational issues, as well as improving CX by enabling more connected retail stores' experience?
Product selection features from retailers valued most by the omnichannel shoppers (P)	P1	Taking into account the overall increase in prices (utilities, fuels, foodstuffs), do you have a more pronounced orientation towards discount stores?
	P2	If do you feel a decrease in your purchasing power, can you say that there is an increase of your interest in private label brands (sold under a retailer's brand name, the product being acquired for sale through a particular provider)?
	P3	As a shopper, do you think that a product detail page can make succeed an e-commerce brand/retailer?
	P4	As a shopper, do you think that product selection is an important category of retail features?
	P5	As a shopper, do you feel a certain degree of emotional attachment towards the products experienced prior to purchase?
	P6	As a shopper, do you think that online reviews are a social proof when seeking out advice to purchase a product?
	P7	Do you agree that the most important need for private labels is customer loyalty?
	P8	Do you agree that the private labels' market power will grow given the difficult nature of the present situation?
	P9	Do you agree that retailers should proactively provide educational content about products sold in their stores?
	P10	Do you agree that a smart return policy of online products you ordered (reverse logistics; an important metric is e-commerce return rate) is impacting your satisfaction as shopper, developing your positive perception of a brand/retailer regarding your overall shopper experience?

Table A1. *Cont.*

Impact of disruptive technologies like the metaverse on e-commerce (E)	E1	Do you think that COVID-19 pandemic activated shifts in your online shopping behavior likely to have lasting effects?
	E2	As a consumer, could you say that you perceive an impact of the disruptive technologies (such as: Artificial Intelligence—AI, Metaverse, Virtual and Augmented Reality—VR and AR, Internet of Things, Blockchain, Advanced Robotics, Quantum Computing, Batteries, Synthetic Biology) on ecommerce?
	E3	Assuming that you are aware, as a shopper, of the importance of the metaverse retail experiences (livestreaming, chat commerce or targeted recommendations and other personalization technologies etc.) do you think that shopping will become more immersive
	E4	Do you think that your shopping experience will be improved by the metaverse technologies (such as AR, NFTs, 3D content etc.)?
	E5	Do you think that your more immersive shopping will be enabled by the try-on technology using your smartphone or tablet (via your devices' camera)?
	E6	Do you think, for instance, that the improvement of social buying capabilities (like recommendation engines, in-app buying, livestreaming, shoppable content etc.) motivate you more to shop and buy?
Data analytics role in retailers' struggling to improve the phygital shopping experience (D)	D1	As a shopper, are you aware of the fact that your convenience is maximized by an appropriate omnichannel arrangement synchronizing your data and the product data across channels?
	D2	Are you aware of the fact that people, process, technology, and data are essential for retailers' ability to improve their operational performance, including your shopper experience?
	D3	Do you know that within their battle to transform efficiency and competitive advantage retailers are under pressure of valorizing investments in analytics and AI, increasing accordingly the contribution of their IT function to organizational performance, including increased product diversity and improved quality and customer satisfaction?
	D4	Do you know that to improve the in-person experience more data on stores are needed by retailers under the pressure of e-commerce for which is simpler to track shopper behavior compared to physical retail?
	D5	As a consumer paying attention to authentic content, do you engage with user-generated content (content created by other people, like written reviews, videos, customer imagery etc.) on your path to purchase (buyer's journey) especially in the final stages of it?
	D6	Do you think that there is a linkage between your shopper engagement with the user-generated content and social commerce (while using your preferred social media app within Meta/Facebook, Instagram, TikTok etc.) as a subset of e-commerce?
	D7	Do you agree that to resolve your pain points within your buyer journey and provide relevant experiences to you retailers need your data to better fit your needs (how you prefer to interact with them, what products and services you are looking for etc.)?

Table A2. The mean and standard deviations for the variables included in this study.

		MEAN	SD			MEAN	SD
					R1	3.929032	1.38083
O	O1	4.506452	0.864602	R	R2	4.105376	1.238803
	O2	4.441935	0.886063		R3	3.707527	1.433844
	O3	3.578495	1.54473		R4	3.747312	1.420903
	O4	3.096774	1.686166		R5	3.763441	1.463572
	O5	3.919355	1.479298		R6	3.739785	1.444722
	O6	3.344086	1.59719			**MEAN**	**SD**
	O7	4.348387	0.977201	E	E1	4.153763	1.152996
	O8	3.139785	1.113489		E2	3.732258	1.346499
		MEAN	**SD**		E3	3.878495	1.266981
					E4	4.105376	1.176407
P	P1	4.543011	0.921446		E5	4.017204	1.250931
	P2	4.435484	0.920189		E6	3.519355	1.430918
	P3	4.106452	1.093311			**MEAN**	**SD**
	P4	4.031183	1.122284	D	D1	2.616129	1.108708
	P5	4.253763	1.002747		D2	4.362366	0.99886
	P6	4.310753	0.919349		D3	3.262366	1.124147
	P7	4.405376	0.928077		D4	3.872043	1.268044
	P8	4.421505	0.923774		D5	4.455914	0.928378
	P9	4.047312	1.114499		D6	3.944086	1.177056
	P10	4.101075	1.09628		D7	2.968817	1.22764

Table A3. Scale reliability.

	Scale	α Cronbach	Number of Items
O. Ever-evolving online shopper is impacting the Romanian phygital retail (O)	1–5	0.774	8
R. Retail features valued most by the omnichannel shoppers and impacting their spending environment (R)	1–5	0.815	6
P. Product selection features from retailers valued most by the omnichannel shoppers (P)	1–5	0.921	10
E. Impact of disruptive technologies like the metaverse on e-commerce (E)	1–5	0.792	6
D. Data analytics role in retailers' struggling to improve the phygital shopping experience (D)	1–5	0.694	7

Table A4. SEM output.

Hypothesis	Relation	β	*p*-Value	Decision
H1	R←O	0.175	0.021	Valid model
H2	R←P	0.144	0.000	Valid model
H3	E←P	0.286	0.014	Valid model
H4	E←R	0.390	0.000	Valid model
H5	D←E	0.220	0.041	Valid model
H6	D←O	0.407	0.145	Risk of 15%

Table A5. Composite reliability, average variance extracted, and discriminant validity metrics for constructs.

Construct	CR (Composite Reliability)	AVE	√AVE	MSV	Max r	Number of Items
O	0.908	0.553	0.744	0.50	0.50	8
R	0.914	0.640	0.800	0.52	0.52	6
P	0.953	0.671	0.819	0.60	0.60	10
E	0.906	0.618	0.786	0.52	0.52	6
D	0.861	0.497	0.686	0.40	0.40	7

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