

Enhancing Consumer Phygital Experience at the Confluence between E-Commerce and E2E Digital Supply Chain Transformation

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Abstract

Taking into account the quickly expanding knowledge body following constantly changing practical applications, we made a critical analysis and synthesis, and identified a significant gap in knowledge as many e-commerce small businesses are still experimenting with the disruptive technologies impacting E2E digital supply chain transformation. And considering the imperative of ensuring supply chain transformation into a consumer-centric supply chain within consumers' rising AI's usage, we focused on actionable steps to face the current real challenge in making a compromise between consumer phygital experience and operational efficiency based on quantifiable measurements ensuring a systematic observation, analysis, and assessment of performance of an e-commerce small business synergistically interacting with the E2E digital supply chain transformation, better understanding consumers' pain points while covering all steps in the supply chain. We also looked in our study at how to deliver personalized and seamless customer journeys within new CX roles' and AI capabilities' alignment, consumer phygital experience enhancement also depending on ensuring both a real-time and unified view of the entire digital supply chain from procurement to delivery, and AI pilots' prioritization with human-in-the-loop governance so as to leverage mutually beneficial synergies between humans and machines based on the right gradually implementation roadmap, learning from the results obtained and advancing accordingly.

Key Words: Consumer Phygital Experience; E-Commerce; E2E Digital Supply Chain Transformation; AI Integration; Behavioral CX Insights

JEL Classification: D83; L21; L81; M21; M31; M37; O31; O33

Introduction

Understanding phygital consumer behavior is of increasing significance today, the challenge of delivering a seamless, integrated, and holistic experience being obvious. As recently stated by the reputed Data-Driven Value Chain Director from The Consumer Goods Forum (2025), Ruediger Hagedorn: "Interoperability is key to unlocking seamless data flow and powerful insights. It enables a pre-competitive, collaborative approach to connecting with consumers, delivering a single, unified customer experience online and in-store." And as data are transformed in material experience and the other way around (the reverse being also true) by the two parts of phygital continuously co-creating one another within the so-called ontological reversal (Baskerville, Myers and Yoo, 2020; Moi, Pusceddu and Cabiddu, 2025), it must be admitted by managers that the organizational reality is constituted by digital technologies, moving to orchestrating the evolving human-AI collaboration forms, and translating them into important phygital experiences based on AI-generated insights interpreted critically. Consequently marketers are struggling to capture consumers' decisions along their journey (supply chains being increasingly design around it, and supporting

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enhanced consumer experiences) based on getting behavioral customer experience (CX) insights (knowledge about the customers), and to impact touchpoints with their offerings along this journey, as well as to measure CX insights' impact including on the e-commerce business (Verhoef, Kannan and Inman, 2015; Holmlund et al., 2020; Purcarea, I.M., Purcarea, I. and Purcarea, T., 2021; Purcarea et al., 2021; Purcarea et al., 2022; Purcarea, 2023; Purcarea, 2024; Baldi et al., 2024; The Consumer Goods Forum, 2024; Purcarea et al., 2025).

E2E consumer journey within digital transformation is becoming increasingly challenging, its visual representation being critical for marketing, sales, product, and support teams, businesses' evidence-based strategies implying to draw a research-driven and evolving map that integrates principal parts (such as: personas, journey steps, documented touchpoints and interactions, emotions and explicit pain points) so as to present a holistic panorama of the consumer experience, looking for consumer behavior models and using obtained insights to optimize the journey, enhancing consumer experience and driving consumer retention (Miller, 2025). And if from the customer's perspective CX across all touchpoints and channels is managed according to the strategic and technological approach (long-term goals' achievement being based on the integration of technology with the business strategy) so-called customer experience management (CXM), from the company's perspective customer relationships with existing and potential customers are managed (customer relationship management – CRM) considering key metrics such as customer lifetime value, revenue, and lead conversion rates.

A recent systematic investigation regarding artificial intelligence (AI) applications integration into CRM, which provided significant practical guidelines to ensure complexities' management, presented, for instance, AI applications covering a variety of CRM processes (marketing, sales, and service), underling among the goals of AI integration into CRM as follows: "a seamless and personalized CX delivery across all channels while effectively managing risks and proactively addressing customer needs to enhance retention and satisfaction; CX improvement and personalization along the customer journey" (Ledro et al., 2025). To effectively implement AI-powered customer journey mapping (Meegle, 2025) organizations can use a range of tools and technologies like Google Analytics, Salesforce Einstein, HubSpot, Adobe Experience Cloud, Zoho CRM. It is more than evident that considerable progress in customer engagement and loyalty can be obtained by AI-driven journey mapping (SuperAGI, 2025).

And as now it is the real time to think of AI Agents (autonomous systems ensuring monitoring, decisions making, and action taking) as supply chain co-workers, according to [x]cube LABS (2025) being recommendable to use them to obtain benefits including from the point of view of: visibility, thanks to a live dashboard view (metrics and data visualizations displayed in real-time) based on data integration by AI agents across ERP (enterprise resource planning), CRM, Internet of Things (IoT), and logistics platforms; CX, AI agents ensuring delivery delays' reduction, in real-time orders' tracking, and errors' minimization. According to Quiq (2025), the leader in enterprise agentic AI for CX, there is an increasing impact of agentic AI on how CX metrics are not only measured and understood, but also optimized, being also highlighted human agents' new opportunities for in partnering with AI to deliver improved CX. As shown recently by the Vice President (VP) and Chief Technology Officer (CTO), Google Cloud (Grannis, 2025), CX is fundamentally changed through hyper-personalization (and giving particular attention to data and user trust) by AI, human experts being empowered by agents, every experience being made by AI truly personal (from data-driven video content to instant suggestions to fans inside a stadium via their mobile devices) based on understanding both intent and context at exceptional scale.

The structure of our paper is as follows: introduction, literature review, research methodology, results and discussions, conclusions and references.

1. Literature review

Recently, OECD (2025) presented the revision of its definition of e-commerce (as a cornerstone of today's digital economy) and its guidelines for interpretation. If in 2001 was adopted its first definition, this new e-commerce definition revision reaffirms the 2009 definition's core principles (as the method of ordering rather than the payment or delivery method; also taking into account that remoteness and automation, as complementary concepts, are at the heart of e-commerce) while refining the guidelines for interpretation considering both emerging business models, and new types of digital transactions. Consequently, e-commerce is defined as follows: "An e-commerce transaction is the sale or purchase of goods or services, conducted over computer networks by methods specifically designed for the purpose of receiving or placing of orders. The goods or services are ordered by those methods, but the payment and the ultimate delivery of the goods or services do not have to be conducted online. An e-commerce transaction can be between enterprises, households, individuals, governments, and other public or private organisations."

By adapting from the well-known Michael Porter's value chain model, Bridges (2024) summarized the seven primary activities and eight supporting activities in a unified e-commerce value chain diagram (as shown in figure below). Bridges underlined that to quickly adjust to evolving consumer preferences, technological advancements, and legislative shifts it is imperative for organizations to become agile by aligning tailored strategic blueprints with customer demands, unique product offerings and market positioning. Within this context, ensuring a seamless and satisfying shopping experience by both understanding and enhancing customer journey is seen as a key factor to center on.

Research findings from 2025 e-commerce trends report by DHL (2025), that surveyed (between February and March of 2025) 24,000 online shoppers across 24 global markets, revealed important aspects such as: social commerce rise and growing opportunities in cross-border shopping, increasing demand for seamless delivery and flexible returns, sustainable practices, as well as for AI-powered e-commerce features. Online shoppers feel frustrated if delivery is not fast or free., delivery and returns being critical, consequently, consumers wanting improvements. The increasing consumers' preference for artificial intelligence (AI) shopping features is transforming online shopping.

According to FasterCapital (2025), modern supply chain dynamics has been profoundly impacted by e-commerce, the activity of supply chain management being changed and challenged by e-commerce (based on technology integration, logistics optimization, CX prioritizing, and data analytics leveraging) in multitudinous ways, the supply chain process streamlining being, for example, one of the primary benefits. To remain competitive organizations need to consider some main points with regard, for instance, to goods' logistics and transportation (last-mile delivery, warehousing and inventory management, transportation optimization, and reverse logistics/returns), a seamless CX in e-commerce supply chain delivery, and consumers' ever-changing demands' meeting (automation and robotics, AI and ML, sustainability, and personalization). E-commerce automation, for example, provides important advantages, such as: time saving and efficiency improvement, human errors' reduction, more easily workflows' execution, and scalability (Novkovic, 2025). To building a reliable e-commerce supply chain (Choco Up, 2025), it is essential to bring together of multiple efforts (vendors, manufacturers and couriers), optimizing the e-commerce logistics process (supplier, warehouse, fulfillment center, carrier, and customer),

and achieving important benefits, such as: faster shipping times, improved inventory accuracy, and more satisfied customers. The flow of materials, products, money and information need to be organized and optimized so as to function well, create positive CX, and build a sound starting point for business growth.

As shown by (Gunnio, 2025), a more flexible and trustworthy approach to automation is the so-called Human-in-the-loop (HITL) AI which operates through a collaborative feedback loop, ensuring mutually beneficial synergies between humans and machines, system's performance being increased gradually this way (significant gains in accuracy, customer satisfaction, and risk reduction being obtained across essential AI applications on the basis of valorizing HITL workflows). HITL AI is seen by Leleko (2025) as "a technical safeguard and a strategic foundation for sustainable AI innovation" capable to address the challenge of "ineffective human involvement in AI systems." On the other hand, to adopt a HITL approach it is recommended (The Beetroot Team, 2025) to have the right gradually implementation roadmap easily available, making small and measurable steps, learning from the results, and progressing on the "way of building trust, accountability, and long-term value in agentic solutions."

Success in customer experience starts with a clear journey showing experiences, emotions, and touchpoints across journey various stages (Fisher, 2025). According to EY (2021), to become a necessary and integrated part of consumers' lives retailers and brands must focus on an experience-led consumer journey requiring a consumer-centered view (the question becoming if touchpoints can be replaced by trust points within consumer journey) of the entire business, consequently starting by considering essential areas (such as: consumer data; technology ecosystem enabling an integrated consumer journey; marketing, loyalty programs and content experiences; supply chain, operations and merchandising). Especially in the context in which to consider buying from a brand 81% of consumers need to trust it, as shown by Maceira (2025), citing a WiserNotify summary of 2025 branding statistics, and highlighting the role of trust in brands' marketing strategy to build a values-based relationship with consumers. According to Salesforce's Director of consumer insights and strategy for retail and consumers (Wood, 2025), as a result, for example, of increased trust in the large language models (LLMs, as third-party AI tools like ChatGPT, Perplexity, and so on), to benefit of hyper-personalized product recommendations and plan shopping budgets shoppers move towards LLM-powered searches.

And as consumer behavior is continuously reshaped by the progressing online shopping (Northern Lights Technology Development, 2025), the supply chain and e-commerce must reciprocally develop, synergistically interact, and amplifying their dynamic relationship. It is also worth remembering some significant approaches: Negricea and Purcarea (2018) underlined digital marketers' need (they being placed at the intersection of digital transformation with CX) to focus on differentiating on digital CX (both digital technology and CX being integral to competitiveness), paying attention to a humanized digital CX, while optimizing Omnichannel CX (both integrating CX with the business model and the operational processes, and ensuring execution rethinking); Purcarea (2018) showed that as the real need of revolutionizing CX through process re-design, co-creation and digital transformation (without forgetting the importance of balancing automation and the human touch) has been already signaled, within an increasing understanding of CX as the brand differentiator, it's time to advance and to go beyond the traditional digital CX metrics; Purcarea (2020) brought to attention how within the sizeable shift to ecommerce and digitalization as a key driver of the supply chain resilience there is a rising omnichannel embracement by retailers struggling to find the right answer to the new requirements of the Supply Chain 4.0 (applying Industry 4.0 innovations) and Value Chain 4.0 (generating and

capturing value in the whole chain using technology usually associated with Industry 4.0 everywhere), while implementing the ECR philosophy, and responsible investing in customer data platforms, AI, ML, and Deep learning.

Supply chains' surprising developments, unexpected changes, and complexities are impacted (Herz, 2025) by consumers' behavior and actions – wants, values, buying habits (inventory levels' directly affecting), preferences (contributing to product development and sourcing decisions' shaping), seasonality trends (stock levels' impacting), reviews and feedback (as powerful influencers within supply chains), engagement, interaction, and outreach (critical for ensuring supply chain efficiency optimization) – in their dual capacity as driving dynamic force and final customer (end user of a product or service). Supply chains' optimization is enabled by a supply chain design based on a customer-centric approach considering consumer perspective, ensuring e-commerce and omnichannel strategies' integration to meet expectations and specific demands, providing real-time visibility, transparency and sustainability, while supporting e-commerce business goals. And as shown by OPSdesign Consulting (a, 2025), supply chains' next evolution is about efficiency plus orchestration having at the center people, creating value together by connecting and collaborating, learning and adapting, progressing on the path to sustainable value creation.

Supply chains' operationally fundamental shift determined by the social commerce allowing to reach consumers where they are brought to supply chains' professionals new both challenges, and opportunities, including valorizing a key differentiator like transparent communication with consumers (OPSdesign Consulting b, 2025). The increasing levels at which disruptive technologies are utilized made it possible to ensure transparent tracking until customer's doorstep, innovative brands already integrating, for instance, into their customer experience (CX) real-time traceability. The transparency and real-time visibility, the personalized service, and uninterrupted interactions from order placement by consumers to ensuring post-delivery support for them are considerably impacting CX improvement.

According to Straight (2025), CX is placed at the center of all decisions within a customer-centric supply chain, by leveraging the disruptive technologies and answering this way to shifting consumer behavior, ensuring the final customer prioritization in designing operations. Within this framework it was made reference to the valuable Gartner's approach regarding the necessary steps (a CX mindset establishment, performance measurement against CX outcomes, CX insights' analysis, and converting these CX insights into action) to transform a supply chain into a customer-centric supply chain. As shown by Sreenivas (2025), consumer behavior is mirrored by artificial intelligence (AI) spending, how consumers experience the world around them being increasingly shaped by consumers' rising AI's usage, consequently marketers being challenged to fulfill expectations.

Findings from a systematic literature review concerning how to accomplish E2E (end to end) Supply Chain Visibility (Razzaq, 2021) revealed that E2E supply chain visibility is hindered by supply chain participants' authorization, data protection, and real-time information access. Both supply chains' E2E visibility (knowing in real time where everything is) and transparency (ensuring visibility sharing with all participants including final customer) are essential (while navigating market disruptions) to ensure delays' minimization, routes' optimization, customer satisfaction enhancement while holding suppliers responsible (Belsley, 2025). Customer expectations are better met by an e-commerce business ensuring E2E distribution (order fulfillment being faster supported by the specific processes), and customer concerns being rapidly resolved by high-quality post-sales services, improving customer loyalty accordingly (Inbound Logistics, 2025).

As shown by Statista (2025), Romanian e-commerce market development is remarkable (confirming its status in Central and Eastern Europe of being one of the most important digital economies), but this development is now threatened by various factors (such as cost of living, inflation rate and price increases). In October 2025 the monthly revenues (price per unit × quantity sold) for this specific market were US\$693m (from preceding month this representing a change of 5-10%), while last year the generated e-commerce revenue was of US\$7,325m (compared to 2023 meaning a growth rate of 5-10%), and a market trending toward a change of 10-15% being projected for 2025 (ECDB, 2025). Emag.ro is continuing to be the most important e-commerce player on our market (last year having an online revenue of US\$1,441m), being followed by aliexpress.com, and temu.com. Also, the e-commerce business startup scene in Romania is interesting, for instance, F6S community (2025) recently presented 61 top e-commerce companies and startups. Last year, in Romania, 72.9% of internet users made purchases online according to the National Institute of Statistics, and as confirmed by the trends highlighted by one of the most popular domestic e-commerce platforms, Gomag (over 4,500 online stores from all industries sell on this platform), AI and automation are increasingly empowering Romanian e-commerce entrepreneurs (Business Days Romania, 2025). According to FGO (2025), as eMAG or international platforms (plus social media channels like TikTok Shop, Instagram Checkout și Facebook Marketplace; plus more and more niche platforms) are constantly improving the shopping experience, and apps are becoming the main shopping channels, an increasing number of consumers are using their mobile phones to buy, being an obvious accelerated change towards mobile payments speedy and protected (Revolut, Apple Pay or Google Wallet being increasingly adopted; the majority of consumers preferring to search online before buying), while the charts being dominated by different product categories (electronics, fashion, interior decoration and food delivery). It is also worth mentioning here that Nistor and Zadobrischi (2024) underlined how the considerable promotional activities on social media platforms carried out in the Romanian e-commerce market (beyond the dominant force represented by Amazon) by the emergent Chinese e-commerce giants Shein and Temu explained the path of consistent predictable expansion over time (as daily order volumes). A report by MerchantPro (2025), including Statista data, showed that 64% of Romanian consumers shop on international sites mainly for lower prices, 47% of them turning to these products that are not available in local stores.

The Executive Director of the Romanian e-commerce association ARMO (launched in 2010; it is a member of Ecommerce Europe) underlined in an interview published in European E-commerce Report 2025 (Weltevreden, 2025) significant aspects, such as: the implementation of parcel-locker networks (determining van-kilometers' cutting, failed deliveries' reduction, and batch returns' enablement) represents the quickly growing trend within the rapidly expanding sustainable logistics; according to the Digital Economy and Society Index (DESI, that summarised indicators on Europe's digital performance and tracked the progress of EU countries) 2025, a basic level of digital intensity being reached by only 22–27% SMEs (just 12% of SMEs selling online), meaning that from the point of view of digitalization our SMEs remain below the European Union average, but our SMEs can shift to genuine transformation (from digital basics) based on digital transformation (progressing from essentials like e-invoicing and digital payments) and innovation supported by dedicated programs; Romanian consumers are increasingly preferring parcel-lockers and pick-up/drop-off points on delivery, consumers, valuing round-the-clock access, fewer failed deliveries, and greater privacy, a behavioural shift explained by the policy developments' reinforcement, as locker expansion and electric vehicles (EVs) fleets are becoming priorities, supported by European Union and Romanian state funding; the rural penetration, better broadband coverage (increasing households' proportion accessing a certain speed of internet), and the click-and-collect points' implementation in smaller towns are continuously driving the growth of e-commerce, while mobile commerce and the rise of q-commerce

(giving priority to quick deliveries, valorizing innovations in last-mile delivery) are further supporting consumers' structural shift toward digital channels; the working together of the e-commerce and courier sectors are also essential, especially in the general context in which the pressure of meeting shifting consumer expectations (within the current context impacted by inflationary pressures) is challenging e-commerce players to integrate convenience and price competitiveness, as well as innovation. Very recently, the same ARMO Executive Director made reference (Dorombach, 2025) to the fact that the Black Friday event is an annual confirmation of the maturity of our online commerce (not simply a discounts' day).

Coming back to the above-mentioned eCommerce Insights report by MerchantPro, that conducted a complete analysis of the Romanian online commerce, it is worth underlining some significant aspects, such as: from the point of view of the e-commerce market structure there is a polarization between the numerous and flexible small players (representing 98.3% but generating only 41% of the e-commerce sector's turnover) and large companies (generating 1/3 of the e-commerce market's revenues despite the fact that represent only 0.025% of the total), but there is a significant potential for both a better balance in the market, and a diversification of competition, in context of the accelerated growth of 31.6% in turnover recorded by the medium-large companies (50-249 employees); Romanian consumers are increasingly choosing to buy from large marketplaces, being imperative for retailers to adjust their strategies to remain competitive; over 60% of customers have over five years of experience in online purchases; the average annual value of an online customer is 857 Euros (according to Statista estimates); online commerce is redefined by Gen Z, a young consumer segment preferring mobile platforms, being based on video content to buy, and valuing sustainability; Bucharest-Ilfov, with 64.1%, is the most active area in e-commerce is; through progressive adoption the rural shoppers are fueling (through a higher adoption of those in urban areas) online commerce growth, being more likely to buy from Romanian merchants if they offer them a simple and efficient shopping experience; when choosing an online store Romanian consumers prioritize the following factors: free delivery (41% of respondents), detailed product descriptions (27%), cost transparency (24%), free returns (21%), and flexible options (such as cash on delivery or direct home delivery); the most popular product categories are beauty and personal care products (64%), fashion, footwear, pharma and electronics.

We crafted the above-mentioned literature review considering the quickly expanding knowledge body following constantly changing practical applications, by struggling to make a critical analysis and synthesis, and identify gaps in knowledge as many small businesses are still experimenting with the disruptive technologies, so as to guide us in the formulation of hypotheses and the overarching strategy for this study. This relevant context made us see the current real challenge in making a compromise between consumer phygital experience and operational efficiency based on quantifiable measurements ensuring a systematic observation, analysis, and assessment of performance of an e-commerce small business synergistically interacting with the E2E digital supply chain transformation, better understanding consumer journey and using actionable data to improve consumer satisfaction (through optimized workflows, and personalized interactions), assuming professional roles like CX manager, product category manager, consumer journey analyst, and operations specialist optimizing e-commerce small business workflows to increase both efficiency, and productivity. To enhance consumer experience, the e-commerce small business progressing on the path toward E2E digital supply chain transformation also needs: to ensure a real-time and unified view (integrated E2E visibility) of the entire digital supply chain from procurement to delivery (with the help of the new technologies promoting interdepartmental communication, and of ensuring proactive management enablement, better inventory control, risk management improvement, and data-driven insights

increasing efficiency); to ensure AI pilots' prioritization with human-in-the-loop (HITL) governance so as to leverage mutually beneficial synergies between humans and machines based on the right gradually implementation roadmap, learning from the results obtained and advancing accordingly.

2. Research methodology

Our above-mentioned literature review and practice allowed us to identify a significant gap in knowledge as many e-commerce small businesses are still experimenting with the disruptive technologies impacting E2E digital supply chain transformation. And considering the imperative of ensuring supply chain transformation into a consumer-centric supply chain within consumers' rising AI's usage *the main objective of our research* was to identify consumers' pain points occurring across the entire lifecycle of e-commerce small businesses' consumer's purchase (covering all necessary steps in the supply chain), from placing an order and receiving the product to the process of returning it and making a compromise between consumer phygital experience (CX) and operational efficiency with the support of AI pilots' prioritization based on the working together of demand forecasting and personalized communications. *The secondary objective* was to ensure the e-commerce supply chain digital transformation so as to reduce operational cost by 20-25%, improve fulfillment accuracy to 85-90%, and increase customer satisfaction (obtaining a favorable Net Promoter Score above 20 points) by valorizing the above-mentioned AI, automation, and customer journey insights (in this last case considering including CX roles' organizational chart suitable for an e-commerce small business). Consequently, the research question was if a young small e-commerce retailer can ensure an E2E digital supply chain transformation design and implementation so as to deliver personalized and seamless customer journeys within new CX roles' and AI capabilities' alignment while reducing operating costs based on business processes and resources' optimization.

To break down these two (specific, measurable, achievable, relevant, and time-bound) objectives into actionable steps, tracking progress, and ensuring objectives' alignment with the research question we joined forces with a young small e-commerce business (where the CEO also assumed the role of COO to supervise closely both strategic planning and daily operations, and the marketing manager also assumed CX roles to begin to have a more holistic view of the customer journey), a joint decision being reached from the very beginning (while paying attention to ethics, privacy and governance) with regard to the following steps of our project:

- *Success criteria* (to ensure: supply chain data harmonious integration across vendors and logistics; customer interactions' personalization and automation; proactive management of risks and performance optimization based on predictive visibility not only for stock and delivery, but also for returns; CX improvement measurable in both Net Promoter Score (NPS), and repeat purchases), *as well as Key Performance Indicators* (KPIs) and *success metrics*: for CX, NPS above 20 points (as KPI), and 20 months (as target); for Fulfillment, 85-90% on-time deliveries, and 14 months; for Inventory, 12% stockouts' reduction, and 14 months; for Automation, 60% customer queries handled by AI, and 17 months; for Returns, 18% returns' reduction, and 20 months; and for Profitability, 8% Cost-cutting (CTS), and 20 months;
- *An indicative budget to guide initial decision-making* (with the final budget to be approved after more details will be created during the planning process): Web-based applications for on-demand access, including business applications (ERP, CRM, AI) – €15,000-18,000; Data integration and APIs – 6,000-8,000; AI and automation (agile) pilots (to measure, refine, and scale) – €18,000-20,000; Training and change management to effectively stimulate agile adaptation to new processes and technologies - €2,500-3,000;

- *Common stakeholders and their roles*: CEO/COO of the e-commerce business being responsible for strategic direction and budget approval, as well for overall delivery and outcomes; CTO being responsible for architecture, integrations, and data security; Joint data science team being responsible for AI model development and analytics; Marketing manager/CX in partnership with external partners being responsible for customer journey mapping (to anticipate customer needs at different journey stages and ensure personalized marketing strategies' enhancement); Operations manager being responsible for the links connecting the entire supply chain based on the working together of warehouse (central hub for storage and distribution), logistics (transportation, storage, and handling of goods), and supplier (the goods' source, the supply chain starting point); Vendors as external partners responsible for Application Programming Interface (API), Third-Party Logistics (3PL), AI tools (as software applications using AI algorithms to perform specific tasks and solve problems);
- *Project key deliverables as landmarks for tracking progress*: Mapped pain points for Gen Y, Gen Z, and Gen Alpha within customer journey maps (completion date – Month 3); Vision, scope, and timeline within a digital transformation roadmap (completion date – Month 4); Central data repository and APIs allowing data uploading within unified data infrastructure (completion date – Month 8); AI forecasting (predicting customer demand and personalizing product recommendations) to make better-informed decisions about CX within AI forecasting and CX tools (completion date – Month 14); Real-time tracking and self-service technologies allowing for immediate monitoring within automated fulfillment and returns (completion date – Month 17); E2E KPI system within CX dashboard and optimization framework to ensure pain points' identification (by tracking key metrics like NPS, CSAT, and CES) and inform decisions, as well as to make strategic changes based on this data to ensure loyalty enhancement and churn reduction (completion date – Month 20);
- *Project timetable (stage, duration, landmarks, and dependencies)*: 1. Assessment, up to 3 Months, CX mapping and roadmap, None; 2. Data integration, 3–8 Months, Unified data model, Stage 1; 3. AI Enablement, 8–14 Months, Forecasting and personalization, Stage 2; 4. CX Automation, 14–17 Months, Delivery automation and returns, Stage 3; 5. Optimization, 17–20 Months, CX dashboard live, Stage 4.

We used a combination of both quantitative and qualitative approaches, plus pilot testing:

- With regard to sampling methods there were considered 4 internal stakeholders to understand processes, data, and CX alignment (current role and key responsibilities description; "good CX" definition; steps of the supply chain most influencing CX; where do breakdowns or delays typically occur; currently data use or technology to monitor customer satisfaction; AI or automation tools we are experimenting with; making our work more effective in serving customers; teams' currently collaboration on CX improvements; the biggest barriers to digital transformation; what would "success" look like to us after this project);
- With regard to customer sampling to identify journey pain points and CX expectations:
 - There were conducted 20 qualitative standardized interviews based on significant questions (how often do you shop online with small Romanian e-commerce retailers; your last shopping experience, from browsing to delivery, description; what made it easy or frustrating; how do you prefer to receive delivery updates; how important is transparency about stock and delivery time; what would make returns or support interactions smoother; how do you feel about personalized offers or messages);
 - There were obtained 124 short quantitative surveys responses (scale: from 1, strongly disagree to 5, strongly agree) to significant questions (received timely and accurate delivery updates; product arrived when promised; simple return process; store understood my

preferences; NPS question: I would recommend this retailer to others; I would shop here again), customers being stratified by order frequency (one-time, occasional, and frequent buyers), purchase value, and geography (urban/rural), in order to also ensure resources' prioritization, strategies' tailoring, profitability improvement, and efficiency enhancement;

- Pilot testing (objective, actions, and deliverables / metrics): 1. E2E supply chain visibility (based on unified and valuable dataset essential for real-time inventory and fulfillment stage, as well as for returns status) and CX feedback loop (reinforcing consumer voice and engagement, improving future performance); integrate order plus delivery tracking into a unified dashboard, automate post-purchase messages, launch short NPS survey; dashboard live, reduced customer inquiries; 2. AI demand forecasting (demand sensing allowing including rapid reaction to consumer behavior shifts) plus personalization; forecasting deployment for top 20 SKUs, personalize post-purchase updates or product recommendations, measure uplift vs control group; pilot report, improvement in On-Time (delivery arrives by the scheduled date), In-Full (order contains the correct quantity of every ordered item) – OTIF, ensuring the assessment of delivery performance and customer satisfaction, greater efficiency being indicated by a higher OTIF.

Knowing the importance of real-time data visibility, we took into consideration that it is provided by integrating supplier and fulfillment systems via APIs, organizations: being enabled this way to ensure processes' automation, efficiency improvement, and rapidly responding to disruptions; managing to provide an E2E view of their supply chain with the help of APIs that facilitate seamless data flow (as automatically and ceaselessly data movement process between different systems such as warehouse management, inventory, and order management) and making possible inventory control improvement and order processing optimization, as well as customer service improvement. Then, we considered (in both modern business intelligence, and analytics platforms being seen as a common feature) automated insights enabling easily accessible dashboards and reports' creation, in light of this AI needing to be concentrated on forecasting, personalization, and CX. To avoid heavy custom development (meeting a specific business's unique requirements with the help of software created from scratch), we opted for achieving the desired outcome while using the least amount of money (cost-effective solution with rapid deployment and automatic updates) preferring to leverage a modular Software as a Service (SaaS – remotely delivering applications over the internet) approach. And to repeatedly perform the planned actions' cycle, ensuring results' evaluation and fast improvements' making to achieve more rapidly the desired outcome we also opted to conduct short and low-cost experiments (as AI and automation agile pilots to measure, refine, and scale). Also, to ensure CX, loyalty, and retention measurement and improvement (to determine how effective are the changes, by collecting data to understand current performance, identify areas enhancement, and track progress), we used, as a visual tool ensuring key metrics' tracking, a customer-centric KPI dashboard displaying in real-time data – like for example, NPS (that estimates customer loyalty by asking how likely consumers are to recommend a product or service) – to help the e-commerce small business ensure trends' identification, processes' optimization, and customer needs' better understanding.

3. Results and discussions

It is well-known how important are generational behavioral considerations from the point of view of market insights (to develop targeted marketing strategies and products that attract these generations' specific needs and preferences based on actionable insights), informed policy (based on generational differences' better understanding), and social cohesion (based on clear identification of the influences shaping these generations as common patterns of thinking, acting, and believing, then encouraging the development of connection between

them, of empathy). Consequently, focused on improved CX and predictive personalization, we targeted three generations, struggling to identify pain points for each cohort (Gen Y, Gen Z, and Gen Alpha) and to enter this information into AI training datasets as data collections fueling machine learning and deep learning models to learn and make predictions. The analysis of generational behavioral considerations (generations' traits; supply chain directly impacting CX / CX implications) confirmed significant aspects, such as: (a) for Gen Y consumers: value convenience and transparency, purchasing decisions being influenced by trust; real-time tracking providing instant data on shipment status, and loyalty programs valorizing supply chain data to offer personalized deals and restock alerts informing consumers when out-of-stock items becomes available again; (b) for Gen Z consumers: social-commerce driven, directly purchasing within the social media app; eco-conscious prioritizing sustainability, and seeking to minimize their ecological footprint; sustainable packaging minimizing environmental impact, and influencer logistics allowing to send products to influencers for marketing campaigns; for Gen Alpha consumers: digital-native preferring instant gratification, seamless experiences, and constant access to information and services; predictive analytics in CX to anticipate consumer needs and behaviors, AR/VR try-ons letting consumers virtually try on products using their own devices, ultra-fast fulfillment ensuring products delivery to consumers through quick-commerce models.

Also, research findings revealed other significant aspects, such as: compared to above-mentioned cross-border low-cost players, there are essential competitive differentiators from local players (with regard, for instance, to delivery options like parcel lockers and returns); consumer anxiety is minimized by both transparent communication, and improved real-time tracking, being a close correlation between consumer phygital experience and supply chain visibility; there is a clear need for an e-commerce small business to assume cross-functional CX roles and improve detection of rapid changes in consumer behavior, quickly adjusting not only the inventory, but also the digital supply chain plans by ensuring E2E processes' transformation based on the right roadmap, leveraging AI integration; it is imperative for an e-commerce small business to make a compromise between consumer phygital experience and operational efficiency based on quantifiable measurements ensuring a systematic observation, analysis, and assessment of its performance, minimizing consumers' pain points while covering all steps in the supply chain.

Conclusions

After launching the (still ongoing) project in February 2025, assessing the progress, we have seen specific advancements already after nine months. Thus, as a significant portion of the project work is underway, a summary of the results obtained after the first nine month from the above-mentioned launch were as follows: as organizational metrics – data visibility on the right track to be achieved across systems, and CX role on the right track to be formalized; as operational metrics – minus 9% stockouts, and minus 7% late deliveries; as CX metrics – plus 5% NPS improvement; as engagement – plus 5% repeat purchase rate, and minus 12% support tickets (as contents of customer's message about request details: issue raised, priority level, and status).

Consequently, continuing to move further with the project, we will move forward with the next stages of the project, considering the following useful practical recommendations: to strengthen data governance (organization's data availability, quality, and security) and model monitoring (ML models' performance tracking and analyzing); to both add personalized CX flows (recommended products flow: personalized recommendations, "frequently bought together" suggestions, and e-mail-based recommendations; self-service

returns flow: returns portal, item selection, label generation, status tracking), and measure uplift (the incremental improvement in CX); to formalize CX metrics into objective and key results (OKRs focusing on meaningful results like improving NPS) and compensation (an OKR objective being often supported by 3-5 KPIs providing different measurement angles).

As recognizing limitations and risks' existence is essential to better understand the research's validity (as well as guide future research), it is important to underline them: findings' generalizability is limited due to the small sample size, consequently being recommendable a replication across other businesses; as an e-commerce small business is facing data constraints, it is recommendable to use simpler ML models (as trained algorithms suggesting, for instance, products or content based on user behavior); short-term risks in fulfillment and routing may cause not only lower delivery capacity and reduced consumer satisfaction, but also higher costs; personalization presupposes to obtain consent so that is freely given, specific, informed, unambiguous, and explicit (to avoid non-implementation of GDPR-aligned consent); to avoid regulatory and privacy risks (consequences of non-compliance being significant: loss of customer trust, financial penalties, reputational damage) it is necessary, for example, to obtain GDPR-aligned consent for personalization.

Regarding future research areas, by building on our findings, we suggest as follows: if ML decisions in fulfillment and CX can be effectively and efficiently supervised by small teams valorizing human-AI collaboration models, combining human's input (based on ensuring that project is working correctly on the right track) and AI's output (based on information and analysis), knowing, for instance, that more human involvement is required by higher risk situations, and choosing a suitable approach (balanced collaboration, human-in-the-loop, human-on-the-loop, human-out-of-the-loop or human-in-command); the extent to which CX results can be improved by combining Direct-to-consumer (DTC) selling and via marketplaces selling, valorizing both strategies' benefits; the extent to which CX and costs are affected by greener fulfillment options (such as: providing incentives to consumers choosing greener options; better inventory management minimizing waste, sustainable packaging, energy-efficient warehousing, eco-friendly transport methods, entering in partnership with 3PLs providers supportive of sustainable practices, fuel consumption reduced by shipping routes' optimizing), managing compromises between sustainability goals and anticipated expenses involving disruptive technologies and innovative practices' utilization to ensure consumers demands with supply chains' alignment, organizational long-term resilience building, and brand reputation enhancement; the extent to which CX investments' longitudinal ROI is confirming a worthwhile investment for the e-commerce small business, directly linking CX efforts to financial outcomes (considering both direct revenue increases, and cost savings from reduced churn and improved operational efficiency), and ensuring customer lifetime value (CLTV) uplift exceeds operational costs, by comparing (towards the end of the project) the increase in a customer's total value against the ongoing costs of running the small business (measured by total expenses, such as cost of goods sold and operating expenses) to make sure of expected cost-effectiveness; the extent to which compliance requirements' integration into a small organization's daily processes and technologies (explainability to a human in AI governance being critical for transparency, accountability, and regulatory compliance, as well for consumer trust) to

make them more efficient and lighter, being helpful to manage risk and satisfy the requirements with reduced indirect costs; the extent to which e-commerce customer journey is transformed by embedding AI-driven feedback loops at every stage, increasing impact on CX.

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