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How to use emerging service technologies to enhance customer centricity in business-to-business contexts: A conceptual framework and research agenda☆

Nancy V. Wünderlich [a,*], Markus Blut [b], Christian Brock [c], Nima Heirati [d], Marcus Jensen [e], Stefanie Paluch [f], Julia Rötzmeier-Keuper [g], Zsófia Tóth [b]

[a] Technische Universität Berlin, Chair of Digital Markets, Straße des 17. Juni 135, 10623 Berlin, Germany
[b] Durham University Business School, Riverside Place, Durham, DH1 1SL, UK
[c] University of Rostock, Chair of Marketing, Ulmenstr. 69, 18057 Rostock, Germany
[d] University of Surrey, Rik Medlik Building, Guildford GU2 7XH, UK
[e] University of Rostock, Marketing Research Group, Ulmenstr. 69, 18057 Rostock, Germany
[f] RWTH Aachen University, Chair of Service and Technology Marketing, Kackertstr. 7, 52072 Aachen, Germany
[g] Technische Universität Berlin, Digital Markets Research Group, Straße des 17. Juni 135, 10623 Berlin, Germany

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ABSTRACT

Manufacturers in business-to-business (B2B) industries aim to gain a competitive edge by adopting the concept of customer centricity in their strategy. Acknowledging manufacturers' challenges in implementing new technologies, we showcase how digital product passports, augmented/virtual reality, smart products, and digital twins foster customer centricity. We classify these technologies based on their use context and introduce the CC^{TECH}-framework, which delineates the impact of (1) experiential, (2) performance-enhancing, and (3) automated technologies on customer-centric processes. This research explores the opportunities for utilizing specific emerging technologies to enhance four customer-centric processes: (1) interactive customer relationship management (discovering implicit needs), (2) customer integration (systematic involvement of customers in decision-making), (3) internal integration (aligning business activities around customer value), and (4) external integration (supply chain-level coordination to respond to customization required by customers). Further, we provide a technology roadmap for manufacturers and suggest a research agenda to guide future research.

1. Introduction

In recent decades, manufacturers in business-to-business (B2B) industries have increasingly focused on customer centricity to enhance their competitiveness (Lamberti, 2013). Practitioners have emphasized the importance of customer centricity in intensifying competition and offering a distinctive customer experience in the B2B sector (McKinsey, 2020). Customer centricity is a marketing paradigm that places customers, not products, at the center (e.g., Lamberti, 2013; Shah et al., 2006). It involves understanding individual customer needs and leveraging firm resources to develop solutions that meet those needs (Sheth et al., 2000). Although customer centricity has long been discussed, Kannan and Gu (2019) identified a gap in understanding innovative technologies' role in enhancing it. We address this by exploring how emerging technologies, such as digital twins, chatbots, and augmented reality/virtual reality, can strengthen customer centricity in B2B contexts. For instance, Kuka, an industrial robot manufacturer, provides digital twins of robots for production processes at customer sites (Kuka, 2024); Boeing employs augmented reality to enhance aircraft assembly and maintenance (Boeing, 2020); and Heidelberger Druckmaschinen offers smart services such as predictive monitoring through a digital platform (Heidelberger, 2024).

The literature stresses the opportunities of digitalization and emerging technologies for manufacturers (Kowalkowski et al., 2024).

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* Corresponding author.
E-mail addresses: wuenderlich@tu-berlin.de (N.V. Wünderlich), markus.blut@durham.ac.uk (M. Blut), christian.brock@uni-rostock.de (C. Brock), n.heirati@surrey.ac.uk (N. Heirati), marcus.jensen@uni-rostock.de (M. Jensen), paluch@time.rwth-aachen.de (S. Paluch), roetzmeier-keuper@tu-berlin.de (J. Rötzmeier-Keuper), zsofia.toth@durham.ac.uk (Z. Tóth).

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The rise of digitalization and new technologies have shifted the contemporary business environment for manufacturers, sparking a digital transformation across industries (Ahearne et al., 2022; Beverungen et al., 2021). For instance, one study showed that, globally, industrial manufacturers invest around US$318 billion in digital transformation annually (Geissbauer et al., 2022). VinFast, a Vietnamese automobile brand, invested in a fully digital automotive factory, which was realized with closed-loop manufacturing technology from Siemens (Siemens, 2024).

These investments aim to enhance cost leadership, operational efficiency, and productivity but also open doors to innovations, new business models, and improved service quality (Schumann et al., 2012). The shift is fueled by base technologies, including artificial intelligence (AI), cloud computing, 5G/6G connectivity, and blockchain, which are the foundation of emerging back-end (i.e., smart manufacturing and internal operation efficiency) and front-end (i.e., customer-facing activities and services) technologies (Marcon et al., 2022; Meindl et al., 2021). Although research has advanced understanding of base and back-end technologies as enablers of Industry 4.0 (Frank et al., 2019; Kannan & Gu, 2019), less has focused on front-end (hereafter manufacturer–customer interface) technologies in accelerating manufacturers' digital transformation (e.g., chatbots, augmented/virtual reality, digital twins). Such technologies can foster customer centricity and strengthen B2B relationships at customer touchpoints. For example, General Electric generates data streams from connected machines in the industrial Internet of Things, deepening understanding of customer interactions. Analyzing these data enables firms to identify customer needs, implement solutions, and simulate optimization using digital twin technology.

Despite these possibilities, a gap exists concerning the technologies' actual implementation, meaning their maximum capabilities remain unrealized. Many manufacturers grapple with incorporating these emerging manufacturer–customer interface technologies into their marketing and sales strategies. For instance, Geyer and Niessing (2020) discovered that 80 % of B2B firms reported inadequate technological preparedness at the marketing–sales interface, and only 4 % of surveyed firms identified their chief marketing officer as the primary catalyst for digital transformation.

These challenges arise for several reasons. First, in B2B customer firms, adoption of a manufacturer's marketing technology typically does not rest with one individual. Instead, multiple employees in different departments from the customer firm use and assess the technology and engage with it based on their distinct roles (e.g., decision-maker, machine operator). Second, the successful employment of technology at the customer interface depends on whether it supplements or replaces the traditional supplier–customer relationship (Larivière et al., 2017). For example, in an augmenting context, tools designed to aid the sales staff of a manufacturer must also be intuitive for employees of customer firms who interact with them. Conversely, technologies intended to substitute human interaction should be capable of replicating human touchpoints and be easy to understand for employees of the B2B customer firm. Third, technology deployment should be aligned with a clear B2B marketing objective, such as enhancing customer centricity, and evaluated per this goal. However, as previously discussed, the persistence of marketing objectives, particularly maintaining a consistent customer-centric approach, remains challenging for many manufacturers (Lamberti, 2013).

We provide a new conceptual framework, the CC^{TECH}-framework, to support emerging-technology implementation by manufacturers to foster customer-centric strategies. First, we classify manufacturer–customer interface technologies (e.g., digital product passports, augmented/virtual reality) based on application purpose and use context. Second, the CC^{TECH}-framework delineates the impact of (1) experiential, (2) performance-enhancing, and (3) automated technologies on four customer-centricity processes: interactive customer relationship management (CRM; to discover implicit needs), customer integration (customers' systematic involvement in decision-making), (3) internal integration (aligning business activities around customer value), and (4) external integration (supply chain-level coordination to respond to customer-required customization).

Thus, our study offers four major contributions. (1) We illustrate and describe six emerging manufacturer–customer interface technologies (i.e., chatbots, digital product passports, augmented reality/virtual reality, industrial Internet of Things/smart products, digital twins, and platforms) and categorize them into distinct technology groups based on application purpose and use context. Use contexts are differentiated based on the roles of technology users at a customer firm (i.e., strategic decision-maker, operational user) and on the type of technology encounter. Drawing on Larivière et al. (2017), we classify these encounters as either augmenting or substituting. We acknowledge that different user groups use, assess, and engage with technologies based on their respective roles. (2) Further, we shed light on the interplay of three distinct technology groups with customer centricity by developing the CC^{TECH}-framework. Thus, we illustrate the impact of experiential, performance-enhancing, and automated technologies on manufacturers' customer-centric processes at different touchpoints within the customer journey. This allows marketers to evaluate emerging technologies based on their potential value for customer centricity, which addresses the challenge of choosing, designing, and implementing emerging technologies per a customer-centric strategy. (3) Our CC^{TECH}-framework guides manufacturers on harnessing these technologies to achieve their customer-centric strategy effectively. We address the challenge of aligning technology deployment with a B2B marketing objective—namely, enhancing customer centricity. (4) We outline a potential research trajectory, focusing on B2B marketing approaches associated with key emerging technologies.

2. Customer centricity

2.1. The CC^{TECH}-Framework

Based on the key concept of customer centricity, we introduce the novel CC^{TECH}-framework to support manufacturers' deployment of emerging technologies to promote customer-centric strategies. Fig. 1 depicts our organizing framework, illustrating that the technologies and organizational approaches to enhance customer centricity must align with specific moments in the customer journey.

Customer centricity and the customer journey form a relationship that enhances customer satisfaction and business effectiveness. Customer centricity influences different stages of the B2B customer journey, which Purmonen et al. (2023) divide into: (1) the purchase stage, including customers' need recognition, search, comparison of alternatives, and selection processes; and (2) the usage stage, including offering deployment, use, maintenance, and reassessment processes. Customer centricity comprises four processes: interactive CRM, customer integration, internal integration, and external integration (Lamberti, 2013). The customer centricity–customer journey relationship can be intensified through digital technologies due to the detailed and timely information they provide about customers and their changing needs (Kannan & Gu, 2019). For instance, some experiential technologies can enrich the search and selection process by providing immersive experiences. Performance-enhancing technologies support streamlined use and maintenance by automating routine tasks. Automated technologies ensure that customers receive accurate and timely support. Thus, service technologies transform traditional customer

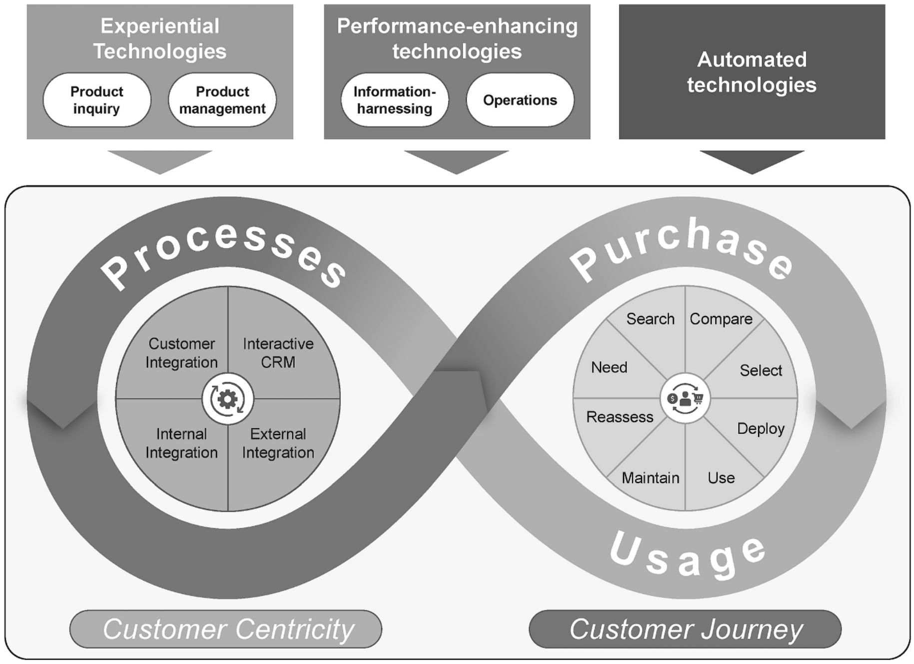

Fig. 1. CC[TECH]-Framework: The Interplay Between Emerging Technologies & Customer Centricity.

interactions and amplify customer-centricity benefits throughout the customer journey.

The remainder of this paper elaborates on the CC[TECH]-framework: Section 2 explores customer centricity and provides insights into its four processes throughout the customer journey. Emerging technologies are introduced in Section 3. Section 4 discusses how three groups of emerging technologies assist manufacturers in adopting customer-centric processes.

2.2. *Customer centricity*

Customer centricity places the customer at the forefront of business strategy, aiming to establish mutually satisfactory customer relationships (Galbraith, 2011; Ulaga, 2018). It involves understanding individual customer needs and utilizing a firm's resources to develop solutions catering to them. Key capabilities for enhancing customer centricity include generating customer intelligence, actively engaging with customers on marketing and innovation efforts, and shifting the focus from products or services to delivering a comprehensive customer experience (Galbraith, 2011; Lamberti, 2013; Ulaga, 2018).

A firm's customer-centricity approach comprises four key processes: interactive CRM, customer integration, internal integration, and external integration (summarized in Table 1).

Interactive CRM involves maintaining continuous interaction with customers to understand their explicit and hidden needs. In maintaining interaction, digital innovation efforts are supported. Interactive CRM enables real-time communication and timely feedback management (e.g., on issues arising during the use and maintenance stages). Interactive CRM aims to facilitate two-way interactions to ensure customers feel heard, which is essential for nurturing business relationships. *Customer integration* systematically involves customers in marketing and new product and service development decisions. It allows firms to understand customers better and respond to their changing needs (Aslam et al., 2023). This supports the creation of positive customer experiences and ensures that firm offerings are up to date. *Internal integration* establishes well-coordinated organizational structures for gathering and sharing customer information across touchpoints. This requires genuine customer-oriented efforts from companies. Internal integration connects all relevant organizational departments for a cohesive customer experience. Cross-functional knowledge sharing can increase internal integration and prevent departments from working in silos when addressing customer needs (Frank et al., 2022). *External integration* is essential in developing a coordinated supply chain to meet customers' customization requirements (Lamberti, 2013).[1] This can include the synchronization of interfaces between external partners (Wang et al., 2024). Overall, collaborating with external partners ensures that customers encounter minimal friction and that roles and responsibilities are allocated between partners.

2.3. *Customer centricity along the customer journey*

Identifying customer touchpoints across stages of the customer journey helps foster customer-centric actions. A deeper understanding of the B2B customer journey enables firms to identify and address their customers' specific pain points, preferences, and decision-making processes, leading to more personalized and effective customer-centric strategies (Hilton et al., 2020). The B2B customer journey is a complex combination of intertwined buying center member paths influenced by various direct and indirect touchpoints and business relationships (Purmonen et al., 2023; Table 1). Purmonen et al. (2023, p. 79) explain that the B2B customer journey "comprise[s] interactions related to the purchase and usage of offerings across multiple indirect and direct touchpoints." Building on this, we distinguish between two stages that describe the key steps of the organizational purchase and usage processes. The *purchase stage* involves (1) need recognition, (2) the search process, (3) the comparison of alternatives, and (4) the selection of an offering. After the purchase follows the *post-purchase usage stage*, which is critical from the customer's perspective: (i) offering deployment, (ii) use, (iii) maintenance, and (iv) reassessment at the end of the usage stage that may initiate a new purchase cycle (Purmonen et al., 2023).

[1] Customer centricity is commonly believed to be rooted in market orientation theory (Sheth et al., 2000). However, it also incorporates the concepts of customer orientation and inter-functional coordination (e.g., Narver & Slater, 1990) in a manner that is more focused on the individual customer and tailored to their needs. Additionally, customer centricity introduces innovative elements (e.g., co-creation and supply chain integration).

Table 1
Key Study Concepts and Technologies.

Core concepts	Definition
Customer centricity	A marketing paradigm that places customers, not products, at the center of interest (Lamberti, 2013). Involves understanding individual customer needs and leveraging the firm's resources to develop solutions that meet those needs (Sheth et al., 2000), and comprises four key processes: interactive CRM, customer integration, internal integration, and external integration.
• *Interactive CRM*	Maintaining continuous customer interaction to understand customers' explicit and hidden needs (Lamberti, 2013).
• *Customer integration*	Systematically involving customers in marketing and new product development decisions (Lamberti, 2013).
• *Internal integration*	Establishing well-coordinated organizational structures for gathering and sharing customer information across all touchpoints (Lamberti, 2013).
• *External integration*	Developing a coordinated supply chain that meets customers' customization requirements (Lamberti, 2013).
Customer journey	A complex combination of buying center member paths, both intertwined and goal-oriented, that are influenced by various direct and indirect touchpoints and the context of business relationships (Purmonen et al., 2023). This study considers two stages of the customer journey: purchase and usage.
Chatbot	Digital service agents that engage in natural conversations with consumers to provide services (Wünderlich & Paluch, 2017).
Digital product passport	A collection of product life-cycle data affiliated with a physical product to enable circular economies through tracking and tracing.
Augmented/virtual reality	Augmented reality enables customers to overlay virtual product models onto their immediate environment, previewing the product when making the purchase decision; virtual reality provides an immersive product experience, allowing the customers to explore and modify different product configurations within showrooms or dedicated spaces.
Industrial Internet of Things	The Industrial Internet of Things is a system or network of devices that use embedded sensors, software, and other technologies to transfer data to one another over the Internet with no human intervention (Belk et al., 2023). It integrates operational technology, such as manufacturing machines and information technology, and enables smart products (Kowalkowski et al., 2024).
Digital twins	Technology that supports the creation of a digital copy or model of a physical entity, be it an object, system, or process; this computerized representation encompasses all operational characteristics of the actual entity, enabling real-time simulation, monitoring, and predictive analysis.
Platforms	Multi-layered modular structures that facilitate interactions between individuals and organizations, allowing them to interact or innovate in otherwise impossible ways (Kowalkowski et al., 2024), such as supply chain platforms, two- or multi-sided markets, and industry platforms.

Mapping the B2B customer journey provides insights into buyer–seller touchpoints embedded in the relational context within the dyad and extended network of firms (Durmusoglu et al., 2022). A deeper understanding of the B2B customer journey can lead to greater customer centricity, informed decision-making, and improved customer experiences at various stages of the customer journey, resulting in increased satisfaction, brand loyalty, and retention, and reduced customer attrition and acquisition costs (Hilton et al., 2020; Shah et al., 2006).

In a business-to-consumer (B2C) context, Kannan and Gu (2019) discuss the impact of technological advances on customer centricity across the customer journey and differentiate between touchpoints across the pre-purchase, purchase, and post-purchase stages. The authors discuss how technology has contributed to every stage of the customer journey by highlighting the role of search engines in capturing customer attention during the need recognition and search stage, the utility of social media in facilitating product consideration and evaluation, and the role of e-commerce platforms in facilitating purchase and providing post-purchase support. Moreover, Kannan and Gu (2019) stress how collecting behavioral and demographic data help firms learn about their customers, better target different customer segments, and provide services that meet customer needs. The authors further discuss the potential of emerging technologies, such as machine learning and AI, to drive real-time and on-demand marketing strategies, as well as augmented/virtual reality, to enrich customer-centric experiences across the B2C journey.

Against this background, we adopt the customer journey perspective in a B2B context and explore how emerging technologies impact customer centricity across stages of the B2B customer journey, focusing on the potential impact of six technologies (i.e., chatbots, digital product passports, augmented reality/virtual reality, digital twins, industrial Internet of Things/smart products, and platforms).

3. Emerging service technologies in B2B marketing

3.1. Classification of emerging manufacturer–customer interface technologies

Digital transformation significantly impacts the relationship between manufacturers and customers, and can even lead to disruption (Hofacker et al., 2020; Lasrado et al., 2023; Wünderlich et al., 2024). For example, the effects of replacing human interactions with automated machine-to-machine interactions in business relationships are not yet fully understood. Further, concerns exist regarding emerging connected technologies' data integrity and security (Hofacker et al., 2020). Many studies have shown that the successful implementation of Industry 4.0 depends on the aligned transformation of manufacturers and customers (Lundin & Kindström, 2023). Therefore, digital transformation impacts multiple actors within business relationships (e.g., manufacturers, customers, and third parties) and creates new ways of serving customers (Kowalkowski et al., 2024).

Modern manufacturers leverage diverse manufacturer–customer interface technologies to enhance and transform their interactions with customer firms (Marcon et al., 2022). These technologies, which are mainly owned or controlled by the manufacturer, vary in their functionality and are handled by different employees across the customer firm. To enhance customer centricity, manufacturers should strategically design and deploy these technologies at customer touchpoints. To better understand this complex interplay, we propose a matrix of manageable groups of emerging technologies at the manufacturer–customer interface. Fig. 2 illustrates this matrix and highlights specific use contexts from the customer firm's perspective.

The matrix depicts the customer firm's experience with the manufacturer's technology. Customer firms include multiple actors (e.g., managers and operational employees) at diverse functional and hierarchical levels who potentially impact digital transformation. These actors' roles and contributions can evolve through various stages of digital transformation, from planning to implementation (Lundin & Kindström, 2023; Witell et al., 2020). Drawing on Oborski's (2003) role definitions for managers and machine operators in modern manufacturing, we focus on two corresponding roles that mirror these groups: strategic decision-makers and operational users. Strategic decision-makers are employees within the customer firm who decide on strategic purchasing, business development, or business model innovation. Operational users are employees who work either directly with data derived from the manufacturer's products (e.g., in the engineering and planning of machine or plant layouts) or with the manufacturer's products in roles such as production management. The individual impact of actors in both roles can support or hamper digital transformation. For example, a lack of digital readiness and the contribution of individual decision-makers in the customer firm could harm purchasing decisions.

The matrix also delineates the types of encounters enabled by the technology. Building on Larivière et al. (2017), who outlined types of technology-enriched service encounters, we distinguish between augmenting and substituting roles. Augmenting technologies supplement

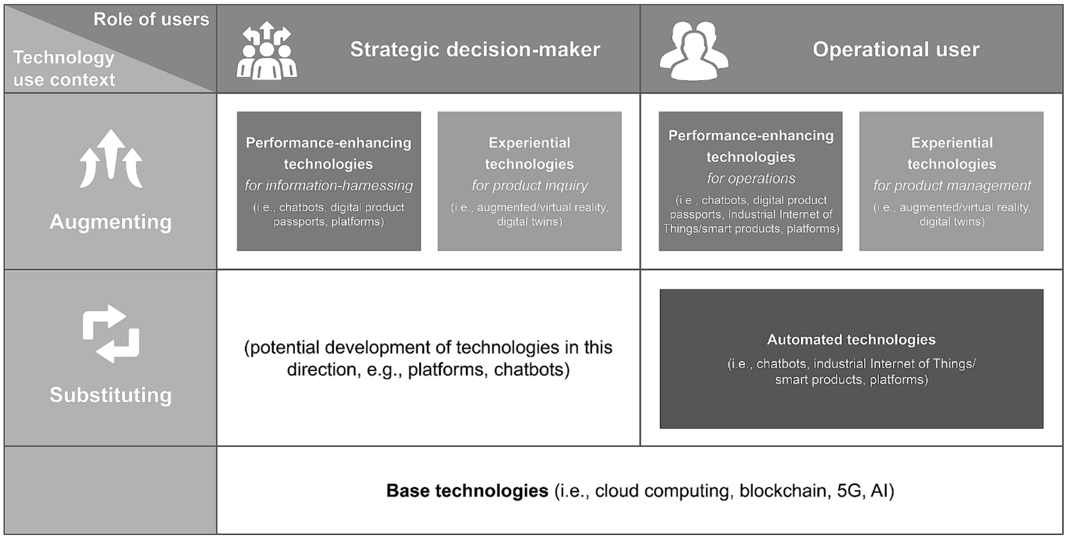

Fig. 2. Classification of Emerging Manufacturer–Customer Interface Technologies.

the personal service encounter between employees of the manufacturer and the customer. Substituting technologies replace such encounters entirely, leading to technology-only interactions on the customer firm's employee side. The intersection between actor and technologies roles results in a classification matrix divided into fields that each represent a specific use context at the customer firm. Each field is defined by the type of technology-enriched service encounter (augmenting or substituting) and the role of the customer firm representative using the technology (strategic decision-maker or operational user).

The matrix underscores the importance of base technologies (e.g., cloud computing, blockchain, 5G, and AI) that provide the foundation for digital transformation (Tsolakis et al., 2023). These technologies provide the essential infrastructure, capabilities, and functionalities that support and empower systems, applications, or services, and form the bedrock upon which other technologies can be integrated into the manufacturer's operations. For instance, Gartner projects that by 2028, at least 15 % of routine work-related decisions will be made autonomously through agentic AI (Coshow, 2024). In particular, the intersection of AI and blockchain technology can transform various business processes by improving their efficiency and effectiveness (Tsolakis et al., 2023). Many manufacturers (e.g., Siemens AG), as well as professional service firms (e.g., Hewlett Packard Enterprise), are adopting blockchain and AI-enabled technologies to accelerate decision-making, empower sales automation, enhance supply chain management, and transform customer interactions (Dwivedi & Wang, 2022). Such technologies also provide a foundation for other technologies (e.g., digital twins, the Internet of Things), smart products (e.g., Internet of Things-enabled connected products), and services (e.g., preventive maintenance).

The classification matrix categorizes five groups of manufacturer–customer interface technologies. In the following section, we introduce selected emerging technologies (chatbots, digital product passports, augmented reality/virtual reality, industrial Internet of Things/smart products, digital twins, and platforms) that many leading manufacturers employ and that represent these five groups. Table 2 provides examples of their applications in manufacturers.

Table 2
Emerging Technologies in B2B Use Contexts.

Technology	Usage context example	Technology	Usage context example
Augmented and virtual reality	Boeing employs augmented reality to support aircraft assembly and maintenance by overlaying digital schematics and instructions onto physical aircraft components. This helps technicians to visualize a machine's function and perform complex assembly tasks.	Digital twins	Lenze uses digital twins to create the conditions for continuous digital engineering for its customers. Digital twins map the physical components of construction equipment and serve as a collection point for all relevant information.
Digital product passport	Circularise provides digital product passports using its blockchain platform for end-to-end traceability and secure data exchange within industrial supply chains.	Chatbot	Danfoss Drive Assistant helps find information, answers questions and troubleshoots motor drives and power converters. It helps find the appropriate software tools for the customers' tasks.
Platforms	Philips Interact is a portfolio of customized, multi-layered applications designed to combine and manage data from connected lighting systems in intelligent buildings and smart cities.	Industrial Internet of Things/smart products	Bosch Internet of Things Suite helps technicians with product development and predictive maintenance. It enables technicians to understand their needs in real-time, improve their operations, and implement innovative features.

3.2. Emerging technologies

Chatbots. Chatbots are digital service agents that engage in natural conversations with consumers to provide services (Blut et al., 2021; Wünderlich & Paluch, 2017). They automatically communicate with customers via text or voice and have the potential to replace human service agents by providing simple and standardized services to many customers at low cost (Dellaert et al., 2020). Whereas early chatbots were relatively simple and reacted to pre-programmed prompts such as “check account,” “cancel order,” or “check delivery status,” more advanced chatbots utilize machine learning and generative AI (e.g., ChatGPT; Blut et al., 2024) to offer complex services and enhance conversation quality (Huang & Rust, 2021). Simple pre-programmed chatbots often struggle to understand customer inquiries, and provide irritating or incorrect answers. AI-powered chatbots, however, are better at mimicking natural human conversation and provide more effective responses (Huang & Rust, 2021). Over the years, manufacturers have routinely employed standardized chatbots on their websites for simple customer inquiries and lead generation, such as providing product information or recording customer inquiries. Chatbots forward customers to a sales agent if they want further information. Therefore, chatbots complement and augment human service agents who address more complex services. Given recent advances in generative AI, manufacturers will likely adopt chatbots to improve customer touchpoints and their overall experience. For example, customers can use chatbots in the post-purchase stage to not only track the delivery process but also maintain after-sales service relationships (Selamat & Windasari, 2021).

Digital Product Passport. The digital product passport is a collection of product life-cycle data affiliated with a physical product, which enables circular economies through tracking and tracing (Jensen et al., 2023). Although the implementation of this digital artifact is in its early developmental state (Adisorn et al., 2021), it is destined to become a pivotal technology promoted by multiple political and governmental entities to safeguard environmental sustainability (Walden et al., 2021). The digital product passport has the potential to provide actors along the value chain with relevant product information. It may contain information on components, materials, and chemical substances, as well as repairability, spare parts, and product disposal (Adisorn et al., 2021). Manufacturers use digital product passports to enhance information transparency and facilitate data-driven decision-making for customers (Jensen et al., 2023). For example, digital product passports might be used to transparently communicate product features that cannot be directly observed (e.g., the sources of a machine’s parts or its ecological footprint), thereby enabling sustainable buying decisions (Jansen et al., 2023). Indeed, the circular economy action plan of the European Union’s Green Deal includes the idea of a battery passport (European Commission, Directorate-General for Communication, 2020), which urges battery manufacturers to transparently communicate important information about the source and origin of raw materials.

Augmented/Virtual Reality. Augmented/virtual reality technologies have revolutionized many manufacturing sectors, specifically by enhancing customer interaction and optimizing operational processes (Kim et al., 2020). Augmented/virtual reality holds immense promise to transform customer engagement, product visualization and customization, support provision, and process simplification for manufacturers (Eswaran & Bahubalendruni, 2022). Augmented reality enables B2B customers to overlay virtual product models onto their immediate environment, providing a preview of the product when making purchase decisions. Virtual reality offers an immersive product experience, enabling customers to explore and modify different product configurations within showrooms or dedicated spaces. Augmented and virtual reality also allow manufacturers to offer virtual showrooms and product demonstrations to customers (Zhang et al., 2023). Such virtual showrooms are particularly beneficial for manufacturers with international customers across various locations. Customers can remotely understand product features, applications, and functionalities without visiting a manufacturer. Concerning customer support, augmented reality enables customers and technicians to receive remote assistance. By using augmented reality-integrated smart glasses or mobile devices, customers can receive instantaneous guidance from technicians who can annotate their live view. Therefore, augmented reality and virtual reality simplify troubleshooting, maintenance tasks, and customer queries, reducing the need for on-site visits (Kim et al., 2020).

Industrial Internet of Things and Smart Products. The Internet of Things is a system or network of devices that use embedded sensors, software, and other technologies to transfer data to one another via the Internet without human intervention (Belk et al., 2023). The Internet of Things provides opportunities for service innovation, enabling manufacturers to connect products directly to customer premises, collect and analyze product usage data, and develop tailored services to improve customers’ operations (Kowalkowski et al., 2024). The industrial Internet of Things integrates operational technology, including manufacturing machines and information technology (Leminen et al., 2020). According to Ehret and Wirtz (2017), several components are essential to this integration. First, information protocols describe how departments (e.g., manufacturing, procurement, sales) and organizations (e.g., manufacturers, third-party suppliers, customers) are connected via the internet or cloud. Second, sensors add connectivity to manufacturing equipment and generate equipment consumption data. Third, actuators are autonomous systems that facilitate ordering raw materials or conducting remote maintenance. Fourth, information-driven services (e.g., big data analytics) enable manufacturers to analyze large amounts of data and generate valuable insights that affect the value and costs of manufacturing (Ehret & Wirtz, 2017). These components form the basis of developing smart products. Implementing the industrial Internet of Things enables manufacturers to transform their traditional customer service and maintenance processes via remote monitoring, predictive maintenance, and automated supply chain optimization (Kowalkowski et al., 2024; Leminen et al., 2020).

Digital Twins. A digital twin is a digital copy or model of a physical entity, be it an object, system, or process (Rantala et al., 2021). This computerized representation encompasses all operational characteristics of the actual entity, enabling real-time simulation, monitoring, and predictive analysis. Digital twins are living models that continually adapt to changes in their physical counterparts by collecting and processing online data and information (Enders & Hoßbach, 2019). In manufacturing, digital twins serve as a pivotal interface between manufacturers and customers. They function as an advanced tool enabling manufacturers to offer new services to customers, such as simulating and optimizing production processes, diagnosing faults, and conducting predictive maintenance and real-time performance analysis (Tao et al., 2019; Zheng et al., 2018). Further, digital twin technology can help manufacturers in pre-sales analytics and usage-oriented design by transforming traditional manuals and product descriptions into interactive, visualized models (Rantala et al., 2021). Therefore, digital twins facilitate product sales and customization by giving customers an advanced understanding of product functions and performance.

Platforms. Platforms are multi-layered modular structures that facilitate interactions between individuals and organizations, allowing them to connect or innovate in otherwise impossible ways (Kowalkowski et al., 2024; Wei & Pardo, 2022). Today, most leading manufacturers offer next-generation industrial solutions powered by digital platforms (e.g., GE Smart Factory, Philips Interact, Bosch Nexeed, Siemens Xcelerator). Digital platforms are based on technology architecture and organizational process architecture within manufacturing and customer firms, enabling coordinated actions, tailored optimizations, and collaborative innovation (Kowalkowski et al., 2024). Eloranta and Turunen (2016) distinguished between supply chain platforms, two- or multi-sided markets, and industry platforms. Supply chain platforms provide common product structures to be created by various actors within the chain. Two- or multi-sided markets are closely associated with offerings and firms mediating transactions (Suarez & Cusumano, 2009). They connect groups of individuals via a platform interface that facilitates transactions between actors. This digital enhancement of purchasing and decision-making processes increases information and process efficiency. However, multi-sided market platforms usually only facilitate transactions, and lack control over offerings exchanged on the platform. Industry platforms enable the creation of complementary products, services, and technologies. In practice, they are embedded in information communication technology environments or in physical spaces where actors cooperate (Eloranta & Turunen, 2016). Industry platforms enable digital functions (e.g., data storage/analytics, condition monitoring, self-learning, and autonomous applications) that allow firms to collect valuable data about product conditions and customer usage to provide new digital services.

3.3. Distinct technology groups

Our classification matrix (Fig. 2) delineates five distinct technology groups based on their application and use context. We identify two groups that primarily serve strategic decision-makers within the customer firm and enhance the personal service encounters between the employees of the manufacturer and the customer: *performance-enhancing technologies for information-harnessing* and *experiential technologies for product inquiry*. Additionally, we delineate *performance-enhancing technologies for operations* and *experiential technologies for product management*, which augment the technology use context but are predominantly used by operational users in the customer firm. Finally, we identify *automated technologies*, which are also applied by operational users but completely replace human encounters. These technology groups are detailed below.

Performance-Enhancing Technologies for Information-Harnessing. These technologies are designed to augment interactions between employees at manufacturers and customer firms. Decision-makers utilize information-harnessing technologies such as chatbots, digital product passports, and platforms to perform their tasks efficiently. The technologies can facilitate communication with strategic decision-makers of a customer firm during the pre-purchase phase, and provide timely and specific product data, market analyses, simulations, or service features. This facilitates the creation of individualized product and service offerings or contracts, forming a foundation for tailor-made offerings during sales interactions. For example, strategic decision-makers can utilize a manufacturer's product training platform to learn about product features and use cases, enabling informed interaction with the manufacturer's sales representative during pre-purchase and purchase phases. Therefore, information-harnessing technologies serve as mechanisms to improve customer knowledge about the manufacturer's products, thereby increasing the efficiency of the sales process.

Experiential Technologies for Product Inquiry. These technologies inform the strategic decision-makers of customer firms by augmenting the interaction between manufacturer employees and decision-makers. They comprise augmented reality/virtual reality and digital twin applications. Their core purposes are twofold. First, they assist strategic decision-makers in "experiencing" or "visualizing" the product, including its features and capabilities. This can take various forms, though a common application could enable decision-makers to "walk through" a digital representation of a machinery layout, gaining a deep understanding of how it operates and might fit within their existing infrastructure. Second, these technologies support strategic decision-makers in collecting product information and understanding it comprehensively during the purchase or pre-purchase phase. This can facilitate decision-making by providing accurate, visual, and interactive information beyond static product descriptions and specifications. An example of this technology group is tablet-based augmented reality/virtual reality applications. For instance, a manufacturer's sales representative could provide a visual representation of a machine in the customer's factory hall using an augmented reality/virtual reality application, thereby assisting the strategic decision-maker in visualizing how the product would fit within their facilities. Hence, experiential technologies for product inquiry provide immersive interactive experiences that aid strategic decision-makers in making informed decisions.

Performance-Enhancing Technologies for Operations. Operational users employ these technologies to improve process and outcome efficiency; they are designed to augment interactions between manufacturers and operational users in customer firms. Examples include chatbots, smart products, digital product passports, and platforms. These technologies support functional and managerial processes and enable users to perform tasks more efficiently. They support operational users through cooperation in partially standardized processes that facilitate the integration of human and digital capabilities for efficient workflows and enhanced operational performance. Moreover, operational performance-enhancing technologies enable close cooperation among B2B partners to safeguard or improve functional relations. For example, a maintenance technician could use an industry platform for the condition monitoring of a machine to augment decision-making for optimized maintenance intervals with the service firm and to enhance overall operational efficiency.

Experiential Technologies for Product Management. These technologies are employed by operational users within customer firms; again, they augment the interaction between the manufacturer's employees and operational users of the customer firm, and involve augmented reality/virtual reality and digital twin applications. They enable operational users to "experience" or "visualize" the manufacturer's product, its features, history, and capabilities, enhancing their understanding of the product and its functionalities. This promotes more effective product utilization and identification of potential improvements or modifications to better serve customer firm needs. These technologies also empower operational users to manage, control, and operate products more effectively. With the ability to create forecasts and scenarios, operational users can anticipate potential problems and make informed decisions to mitigate them. This ensures smooth operations and reduces the likelihood of disruptions. A prime use example of this technology group is digital twins, or virtual replicas, of machines in a production line. Operators can then monitor and interact with the virtual representation, run simulations, and adjust machine settings. Such interaction improves their understanding of the machines and enables them to identify potential problems in advance, increasing efficiency and reducing downtime.

Automated Technologies. Although many technologies support operational users in augmenting existing processes, advances in process automation and smart platforms can substitute traditional operational processes as well as employees. These automated performance-enhancing technologies can create new interaction forms between operational users or between machines across the manufacturer and customer firm. They both replace human interaction and operate automatically, often without operational user intervention. Therefore, these technologies increase operational user performance. Many equipment manufacturers utilize Internet of Things sensor data, analytics, and AI to monitor equipment health, predict failures, and optimize maintenance activities, thus enhancing operational efficiency and reducing downtime. Likewise, firms may analyze customers' operations with data from the Internet of Things sensors and offer automated lighting management systems to reduce energy consumption costs. Automated systems can also run diagnostics and order replacements, thereby driving operational performance and efficiency, substituting traditional processes (e.g., periodic equipment monitoring by manufacturer employees) and interactions (e.g., manual spare-part ordering by the customer firm's employees).

The bottom-left quadrant of the matrix, representing substituting technologies primarily serving strategic decision-makers, currently lacks distinct applications, reflecting early-stage technology adoption in high-level decision-making. Strategic judgments often involve incomplete information, context sensitivity, and personal accountability—factors that currently constrain automation. However, AI advancements may shift this. AI-enabled chatbots and agentic platforms with predictive analytics and adaptive reasoning could support decision-makers by optimizing processes, identifying growth opportunities, and autonomously providing recommendations or making decisions. Rather than strategic decision-making being fully automated, most processes will likely be AI-assisted with human oversight. Moreover, customer firms may favor technologies they have procured, developed in-house, or customized to ensure data security and process alignment in critical decisions.

4. The impact of emerging-technology groups on manufacturer–customer centricity

The following sections highlight how three major technology groups—experiential, performance-enhancing, and automated—assist manufacturers in adopting four key customer-centric processes.

4.1. The impact of experiential technologies on customer centricity

Experiential technologies comprise visualizing technologies, like augmented reality/virtual reality and digital twins. At the customer firm, they provide decision-makers with information about the manufacturer's products; operational users also benefit from the product support these technologies facilitate. Experiential technologies enable manufacturers to adopt the four distinct customer-centric processes along the customer journey.

To foster *interactive CRM*, especially with decision-makers, manufacturers might utilize augmented reality/virtual reality technologies to create immersive virtual showrooms. Such immersive virtual technologies allow decision-makers to view products and their functions, and to interact with the manufacturer's representatives. This enables decision-makers to evaluate products in various simulated scenarios. Such immersive experiences yield valuable data on decision-makers' preferences and latent needs during the purchase phase. Manufacturers could also use augmented reality/virtual reality and digital twin technologies to support operational users. Immersive training, virtual product demonstrations, augmented reality overlay during maintenance tasks, and virtual troubleshooting experiences could foster the relationship between the customer firm's operational users and manufacturers by reducing the learning curve and improving efficiency. Performance and interaction data could provide insights into real-life use cases and indicate when operational users would most benefit from manufacturer support during usage.

Experiential technologies can facilitate *customer integration* by providing tools involving customer firms' representatives in marketing and new product development. Digital twin technologies, for instance, foster comprehensive discussions and contributions from customers along the customer journey. The digital replicas of products or systems enable collaborative co-designing between decision-makers, operational users, and manufacturers, ensuring solutions are integrated seamlessly into customers' existing infrastructures. This level of customization encourages stronger collaboration in the purchase phase, enabling decision-makers from the customer firm to engage with the digital twin and tailor it to their requirements. During usage, technologies such as digital twins and augmented reality/virtual reality empower operational users to actively shape product development. Based on post-purchase experiences and alternative product configurations, feedback from the customer firm's operational users deepens understanding and encourages collaborative discussions on customization options. Thus, customer interactions with augmented reality/virtual reality and digital twins yield valuable insights for potential product enhancements, fostering stronger partnerships throughout the customer journey.

Experiential technologies can also enhance *internal integration* within the manufacturing firm. Technologies such as augmented reality/virtual reality can create immersive spaces where cross-functional teams interact and solve problems collaboratively. Manufacturers can promote coordinated organizational structures where the digital twin data of installed machines are accessible across multiple departments. Intra-organizational teams can interact with and modify digital twin data in virtual environments, thereby enriching their understanding of customer use cases and potential needs. As such, experiential technologies may enable collaboration between traditionally isolated departments (e.g., engineering, manufacturing, sales, and marketing) and improve cohesion among employees, fostering an all-encompassing understanding of the product life cycle at the customer firm. This shared understanding and streamlined communication should improve the manufacturer's internal coordination, enhancing processes and decision-making.

Similarly, experiential technologies can transform *external integration* within the supply chain and foster a coordinated supply chain tailored to the customization needs of customer firms. For instance, digital twins of entire industrial plants could act as orchestrating platforms for multiple product manufacturers, component suppliers, and distributors. Visualizing how all products and components should integrate into the customer's environment can make large-scale projects more comprehensible and transparent for managers, buyers, and operational users. This would also streamline supply chain coordination by aligning products with systems of both customer and third-party entities. Combining digital twins with augmented reality/virtual reality tools enables effective collaboration with suppliers, manufacturers, and distributors, ensuring timely delivery of tailored solutions and a more customer-centric approach to external integration.

4.2. The impact of performance-enhancing technologies on customer centricity

The technologies used to enhance performance and efficiency throughout the customer journey include chatbots, platforms, smart products, and digital product passports. As performance-enhancing technologies focus on information-harnessing, they provide decision-makers at the customer firm with efficient ways to make informed and transparent decisions. Moreover, performance-enhancing technologies focusing on operations provide operational users at the customer firm with various automation and cost-saving opportunities.

To foster *interactive CRM* with customer firm's decision-makers, manufacturers offer chatbots that are frequently employed in lead generation, encouraging decision-makers to schedule product demonstrations or share contact details. This is especially valuable when potential buyers evaluate product specifications during the purchase phase. Chatbots use predefined dialogue structures to guide decision-makers, collect contact information, match customers with suitable sales representatives, and even serve as advertising platforms for manufacturers' products and services. Knowledge-oriented chatbots offer standardized responses and often direct users to relevant web pages. Likewise, after-sales chatbots support operational users in the post-purchase phase. These chatbots streamline service delivery, providing quick and personalized assistance. The benefits include cost reduction, faster response times, and 24/7 availability. After-sales chatbots engage in personalized dialogues to address problems related to support, billing, and more.

Customer integration may be facilitated by digital platforms that apply customer analytics tools and thus enable early integration of the customer firm's decision-makers into the manufacturer's product development processes. Based on specifications created during the search phase, the customization of products, services, or business models can be informed by insights from customer interactions with the platform. Collaborative platforms enable decision-makers to work with developers to co-create products that meet their unique needs. They also permit manufacturers to tap into customer creativity and expertise, strengthening relationships and building partner-like ties during the pre-purchase phase. Moreover, customer integration may function at the operational user level through smart products that collect customer data related to operational issues and solutions. These data are invaluable for enhancing after-sales processes and driving product innovations. Similarly, chatbots are predominantly utilized following sales, providing essential support to operational users by supplying problem-related product and service information. They also assist users with requests or claims, serving as valuable facilitators in the post-purchase phase.

Manufacturers use performance-enhancing technologies like platforms to support *internal integration* and well-coordinated organizational structures to oversee customer interactions across multiple touchpoints. Industrial platforms that enable information sharing and integrate customer data from various channels and touchpoints support a holistic customer-centric strategy. These platforms provide real-time data, synchronize dispersed customer information, and offer integrated business intelligence applications, benefiting different departments within the manufacturing firm. Industrial Internet of Things platforms collect and process data from customer firms' sensors, providing detailed understanding of customer–product interactions. These data are invaluable for cross-functional teams (e.g., product development, marketing, sales, business strategy) in tailoring products, services, and customer experiences to rapidly changing customer needs and environmental factors.

Performance-enhancing technologies are instrumental in facilitating *external integration*. For example, the digital product passport assists in coordinating supply chains to meet customization requirements and implement circular business models. It integrates comprehensive information from multiple partners, suppliers, distributors, and intermediaries, transparently reflecting a product's environmental and social impact. This assists customer decision-making during the search and selection phases, requiring standardized compliance, reporting standards, and meaningful sustainability indicators for sustainability managers. Further, the digital product passport actively involves customers as partners in the circular product life cycle. Customers are encouraged to share data, enhancing their understanding of a product's environmental and social impact and extending beyond product usage. The digital product passport allows any user within the supply chain to access and contribute data, serving as a detailed protocol for product metrics and carrying *meta*-data such as the carbon footprint. Any partner can use these data, and by adding information to the digital product passport they enhance the value for subsequent steps in the supply chain. This external integration streamlines processes, reduces coordination times, and improves overall process efficiency.

4.3. The impact of automated technologies on customer centricity

Automated performance-enhancing technologies such as chatbots, the industrial Internet of Things/smart products, and platforms enable manufacturers to adopt four distinct customer-centric processes during the usage phase. Automated technologies substitute the personal contact between manufacturer and customer firm representatives. Manufacturers apply such technologies to help customer firms' operational users improve performance, reduce downtime, and enhance their output. Regarding *interactive CRM*, automated technologies transform traditional CRM approaches. Industrial Internet of Things/smart products replace human interactions with machine-to-machine interactions. Such technologies allow for the automatization of transactions (e.g., using Internet of Things sensors to automate material ordering) and provide manufacturers with tools to collect and analyze customer data automatically. Manufacturers could use insights from customer use cases to offer operational users information on customer machines and potential future challenges in live operations, fostering the operational user–manufacturer relationship.

Automated technologies also play a role in *customer integration*; for example, they enable real-time data monitoring and collaborative decision-making through smart dashboards fueled by sensor data. Based on these data, products and processes can be further developed, enhancing future performance.

The use of automated technologies also yields improvements in *internal integration*. Connected machines and automated systems of machines at customer sites enable real-time customer data collection across various touchpoints, facilitating the sharing of machine data across departments. Using AI analytics, manufacturers can even automate decision-making. Such technologies replace traditional customer intelligence collection and dissemination processes, introducing unmanned mechanisms for analyzing and addressing customer needs.

Technologies such as digital platforms contribute to *external integration* in the supply chain by facilitating the seamless sharing of machine data with partners, such as the manufacturers of other machines installed at the customer site. For example, manufacturers can offer predictive maintenance to customers by connecting multiple third-party suppliers to a digital platform, and utilize automated processes for replacing parts, installation, and collaborative analysis and resolution of customer issues. This enhances coordination and efficiency within the manufacturer and with other partners.

5. Discussion

5.1. Theoretical implications

Focusing on the digitalization of the B2B customer journey, this study examines how manufacturers leverage emerging technologies to transform customer-centric processes. By examining four key customer-centric processes—interactive CRM, customer integration, internal integration, and external integration—we respond to Lundin and Kindström's (2023) call to manage digitalized touchpoints throughout the customer journey. Furthermore, by combining the existing customer centricity and customer journey frameworks, we demonstrate the transformative potential of emerging technologies. Consequently, we enhance theoretical understanding of the evolving dynamics of B2B interactions in the digital era, leading to three major theoretical implications.

First, we augment the literature on how manufacturers could embrace digital transformation to strengthen their business models (Beverungen et al., 2021) by describing technologies pertinent to manufacturers and providing real-life examples of their application at the manufacturer–customer interface (Table 2). Although research has advanced understanding of base and back-end technologies such as AI and cloud computing as enablers of Industry 4.0 (Frank et al., 2019; Kannan & Gu, 2019), less attention has been paid to the role of front-facing technologies in accelerating manufacturers' digital transformation. By describing six emerging manufacturer–customer interface technologies—augmented reality/virtual reality, digital twins, digital product passport, chatbots, platforms, and industrial Internet of Things/smart products—and categorizing them into groups with similar application purposes and use contexts (Fig. 2), we enhance understanding of how such front-end technologies can be applied in a manufacturing context.

Our classification considers the specific use context of technologies at different customer firm touchpoints through (1) the specific role of the technology user (i.e., strategic decision-maker vs. operational user), and (2) the type of service encounter facilitated by the technology. This provides deeper insights into how digital transformation creates new ways of serving specific actors of a customer firm (Kowalkowski et al., 2024) and impacts manufacturer–customer interactions (Larivière et al., 2017). Using these criteria, scholars can differentiate between experiential technologies for product inquiry (e.g., augmented reality/virtual reality and digital twins), performance-enhancing technologies for information-harnessing (e.g., chatbots, platforms, and digital product passports), experiential technologies for product management (e.g., augmented reality/virtual reality and digital twins), performance-enhancing technologies for operations (e.g., chatbots, platforms, digital product passport, and industrial Internet of Things/smart products), and automated technologies (e.g., chatbots, digital product passport, and industrial Internet of Things/smart products). Future research should investigate the impact of these technologies on strategic and performance outcomes for manufacturers. From the customer firm's perspective, it may be interesting to assess which factors drive the acceptance of these technologies. Moreover, as these technologies mature, barriers to their introduction may diminish, potentially leading to shifts within the classification matrix. For example, currently, digital technologies do not substitute human involvement in strategic decision-making within customer firms. Decisions about business direction and partner cooperation terms still rely on human judgment. However, with the rapid advancement and integration of AI into various technologies (Keegan et al., 2022), reliance on human input is expected to decrease, potentially enabling these technologies to replace human interaction in high-level strategic management decisions.

Second, the CC^{TECH}-framework (Fig. 1) enables us to explore whether, which, and how the three emerging-technology groups impact the four customer-centric processes. Thus, our framework directly addresses the theoretical gap identified by Kannan and Gu (2019) in fully understanding the role of innovative technologies in enhancing customer centricity. We illustrate how emerging manufacturer–customer interface technologies can be implemented to enhance manufacturers' understanding of individual customer needs and leverage their resources to develop solutions that meet these needs (Sheth et al., 2000). These technologies have the potential to enhance customer centricity by supporting manufacturers in the following ways: (1) maintaining continuous customer engagement to generate intelligence and understand explicit and hidden customer needs; (2) systematically involving customers in developing and marketing new products and services; (3) establishing firmly coordinated organizational structures that gather and share customer information, thereby managing customer interactions across all touchpoints; and (4) developing a coordinated supply chain capable of meeting customization requirements. Although many technologies in the CC^{TECH}-framework can impact multiple customer-centric processes, their effects are inconsistent. Scholars should test the predictive power of the CC^{TECH}-framework and empirically assess the impact of the proposed and yet-to-be-introduced technologies on the four customer-centric processes.

Third, we contribute to theory by exploring how emerging technologies impact customer centricity across stages of the B2B customer journey (Purmonen et al., 2023). Adopting these technologies can amplify some touchpoints in the journey while diminishing others. Our study illustrates how emerging technologies create new touchpoints and enhance existing ones, providing a technology-focused perspective that extends the B2B customer journey framework (Purmonen et al., 2023). While these advancements have potential to improve the customer journey, research in this area is lacking (e.g., Purmonen et al., 2023). Moreover, we emphasize that multiple actors within customer firms—across diverse functional and hierarchical levels—interact differently at various touchpoints, adding further complexity to the B2B customer journey. These insights into buyer–seller touchpoints (Durmusoglu et al., 2022) deepen understanding of how emerging technologies can enhance customer centricity through more informed decision-making.

5.2. Managerial implications

The review of emerging technologies presented in this paper can guide firms in designing B2B customer experiences by considering the impact of digital technologies on various functional domains within manufacturers and their customer firms. By classifying emerging technologies based on their potential application (e.g., substituting or augmenting) for different actors (e.g., decision-makers or operational users), we offer an overview of digitalization potentials at the manufacturer–customer interface.

Table 3 presents a technology roadmap by comparing emerging technologies and emphasizing their relevance from a customer-centric standpoint, particularly regarding the customer journey. It evaluates each technology's significance in the context of customer-centric processes, including interactive CRM, customer integration, internal integration, and external integration. Additionally, it highlights each technology's relevance to the purchase and usage stages from the customer journey perspective. Manufacturers should use Table 3 to understand the significance of each technology in a specific context.

For manufacturers using few digital technologies on an ad hoc basis, our overview provides a framework for future development and innovation, such as flexibly complementing human resources. Managers can use the matrix to evaluate potential use cases aligned with their strategic development perspective. Although the initial motivation for manufacturers to invest in emerging technologies may not be a customer-centric approach, we encourage manufacturers at the early stages of digital transformation to conduct a digital technology audit from a customer-centric perspective and strategically plan technology selection. Implementing performance-enhancing technologies like chatbots and platforms can significantly improve information flow, customer knowledge, and communication. Chatbots are particularly beneficial for interactive CRM, and digital platforms enhance external integration. Our classification of emerging technologies can guide manufacturers and customers to better match their B2B relationship needs with the benefits of different emerging technologies, thereby improving manufacturer–customer interactions (Larivière et al., 2017). Manufacturers may use this classification to assess their own and customers' digital maturity requirements. By considering partners' digital maturity levels, firms willing to employ new technologies may work more efficiently with similarly flexible firms than those with inertia. This alignment enhances the successful implementation of technology through coordinated transformations of manufacturers and customers (Lundin & Kindström, 2023). For manufacturers with limited use of digital technologies, representing low digital maturity, we recommend initially employing information-harnessing and operational performance-enhancing technologies to augment tasks, as these have lower implementation barriers and higher acceptance rates versus technologies meant to substitute interactions.

Table 3
Technology Roadmap: Relevance of Technologies.

Technology	**Customer centricity**				**Journey**	
	Interactive CRM	***Customer integration***	***Internal integration***	***External integration***	***Purchase***	***Usage***
Experiential technologies						
• Augmented reality/virtual reality	+++	+++	+	++	+++	+++
• Digital twins	+++	+++	++	++	+++	+++
Performance-enhancing technologies						
• Chatbots	+++	++	+	+	+++	+
• Platforms	+	+	++	+++	+++	+++
• Digital product passport	++	+++	+	+++	++	+++
• Industrial Internet of Things/smart products	+	+	++	+++	+	+++
Automated technologies						
• Chatbots	+	+	++	+++	+++	++
• Digital product passport	+	+	++	++	++	++
• Industrial Internet of Things/smart products	+	+	++	+++	+	+++

+ low relevance; ++ medium relevance; +++ high relevance.

Our CC^{TECH}-framework offers managerial implications for enhancing customer centricity using emerging technologies. Effectively implementing these technologies along the customer journey can improve customer experience and operational efficiency, as many manufacturers find maintaining a consistent customer-centric approach challenging (Lamberti, 2013). Managers can use the CC^{TECH}-framework to select and implement emerging technologies at the manufacturer–customer interface, aligning digital strategies with customer-centric objectives. Larger corporations can enhance their market position, CRM, and operational processes by using this framework as a strategic map for understanding the role and application of different technologies. For example, experiential technologies (e.g., augmented and virtual reality) can improve customer integration processes.

Integrating emerging technologies is a significant step toward customer centricity for manufacturers, but it is not without risks. Organizational inertia—a firm's tendency to resist change due to established routines and structures—is challenging. Firms often face technological turbulence from frequent new technology introductions but are ill-prepared to respond (Wang et al., 2021).

By adopting the strategies and frameworks discussed herein, manufacturers can better navigate the complexities of digital transformation. This is essential for assessing the prerequisites for implementing new technologies at various touchpoints to comply with new regulations (e.g., mandatory use of digital product passports), fulfill data security requirements, or adhere to customer and partner requirements. Base technologies (e.g., cloud computing, blockchain, 5G, and AI) provide the infrastructure required to implement emerging technologies at the manufacturer–customer interface (Tsolakis et al., 2023) but also introduce vulnerabilities, making cybersecurity a primary concern. Manufacturers must address information security issues (Hasselblatt et al., 2018) and invest in robust measures, such as encryption and authentication, to ensure stable, safe, and sustainable operations.

Additionally, ethical considerations are important. For instance, AI and customer data collection can raise ethical, privacy, and fairness concerns. As manufacturers become more data-driven, they must adopt responsible data practices and digital corporate responsibility (e.g., Lobschat et al., 2021) to maintain customer and stakeholder trust.

5.3. Future research implications

Having explored emerging technologies and their impact on customer centricity, we now present a future research agenda, inviting scholars to unravel the complexities of emerging technologies and their profound impact on customer centricity in a B2B context. Manufacturers navigating this landscape must examine the challenges and opportunities of deploying such technologies. Although we provide several insights, pressing issues warrant further investigation.

The evolving B2B marketing technology landscape continues to reshape manufacturer–customer firm interactions. Advances in digitalization are subject to ongoing research, which sheds light on the implications for B2B marketing and customer centricity. Thus, we present future research avenues related to our key findings (Table 4).

First, *experiential technologies* have a profound impact on all key processes of the customer-centricity approach. For instance, scholars should explore how these technologies influence interactive CRM. Experiential technologies may significantly enhance customer, firm, and manufacturer relationships. Despite their promise, these relationships' long-term effects and potential moderating influences remain underexplored. Hence, research should assess the long-term effects of experiential technologies on relationship quality. Further, our findings show that experiential technologies facilitate a customized, coordinated supply chain tailored to customer organizations (external integration). Therefore, researchers should assess how B2B partners can improve their skills and capabilities to effectively address customization demands.

Second, implementing *performance-enhancing technologies* can be

Table 4
Customer Centricity Technology and Overarching Future Research Agenda.

Technology groups	Customer-centricity dimension	Key findings and exemplary research questions
Experiential technologies	Interactive CRM	Experiential technologies can strengthen the relationship between the customer firm and the manufacturer and are highly relevant for interactive CRM. However, less is known about the long-term and potential moderating effects on this relationship.Questions: What are the long-term effects on relationship quality? What impact does the implementation have on switching intention? How can these technologies be integrated into the existing system?
	Customer integration	Experiential technologies can foster, for example, more efficient product development, collaborative co-designing, and valuable insights for product enhancement. However, less is known about the potential risk of customer integration (e.g., data integrity and security).Questions: How can customer firms' managers be encouraged to use these technologies fully? What obstacles hinder the adoption of these technologies? How do decision-makers and operational users perceive data privacy issues when manufacturers use augmented/virtual reality and digital twins?
	Internal integration	Even of low or medium relevance, experiential technologies can improve the collaboration between traditionally isolated departments, such as engineering, manufacturing, sales, and marketing. However, little is known about their intra-organizational introduction. Questions: What strategies can firms employ to smoothly integrate these technologies into existing workflows, processes, and systems? How can a digital twin be used to reduce silos and foster a more integrated working environment across different departments? How can augmented reality/virtual reality technologies facilitate knowledge transfer between engineering and marketing departments to enhance product development?
	External integration	Experiential technologies facilitate the development of a coordinated supply chain that is customized to meet the needs of customer organizations, and they hold medium relevance for external integration. Questions: How do experiential technologies influence the engagement and trust-building processes among partners within B2B networks? How can B2B partners effectively improve their skills and capabilities to address customization demands?
Performance-enhancing technologies	Interactive CRM	In terms of performance-enhancing technologies, chatbots are particularly relevant for interactive CRM. Despite apparent benefits such as cost reduction, faster response times, and 24/7 availability, potential risks must also be considered.Questions: What

(*continued on next page*)

Table 4 (*continued*)

Technology groups	Customer-centricity dimension	Key findings and exemplary research questions
		are the risks for the relationship associated with implementation (e.g., the customer is averse to chatbots or standardized answers do not offer a satisfactory solution)? Which information (e.g., customer, products) and databases do manufacturers need to train AI-powered chatbots?
	Customer integration	Performance-enhancing technologies foster the integration of the customer firm's decision-makers into the manufacturer's product development processes. In particular, the digital product passport plays a crucial role in this customer-centric process. However, less is known about this technology-related integration's implementation, impact, and outcome.Questions: What is the influence of performance-enhancing technologies, such as the digital product passport, on the involvement of decision-makers from customer firms in the product development processes of manufacturers? How does this influence product innovation? In what ways can the digital product passport support sustainable decision-making and promote transparency among competitors?
	Internal integration	The data collected by performance-enhancing technologies, particularly from platforms and smart products, are valuable for cross-functional teams—including product development, marketing, sales, and business strategy—to tailor products, services, and customer experiences. However, little is known about the internal application of these technologies.Questions: How can B2B firms assess their internal readiness to integrate these technologies? What strategies can be employed to maximize the internal utilization of platforms? How can the digital product passport be leveraged to improve transparency throughout the product life cycle?
	External integration	Platforms, digital product passports, and smart products are crucial in external integration. These technologies enable the coordination of supply chains to meet customization requirements and allow users within the supply chain to access and contribute data.Questions: How do these technologies influence product metrics such as carbon footprint? What is the impact of performance-improving technologies on the collaboration among various stakeholders in the manufacturer's ecosystem? In what ways is the supply chain or ecosystem transforming?
Automated technologies	Interactive CRM	Automated technologies replace human interactions and thus have a lower relevance for interactive CRM. Nevertheless, there is limited understanding regarding the potential adverse effects on the relationship. Questions: How does the replacement of human interactions affect the relationship? How does access to sensitive production data via digital product passports or smart products affect the supplier–customer relationship?
	Customer integration	In this dimension, technologies such as chatbots, digital product passports, and smart products have a secondary role. Nevertheless, valuable data are collected, which can be integrated into future product development processes. Questions: How can the information collected from technologies such as chatbots, digital product passports, and smart products be optimally utilized in future product development procedures? What privacy concerns emerge when chatbots attempt to personalize communication and recommendations by aggregating sensitive inquiries?
	Internal integration	Automated technologies enable seamless sharing of machine data across different departments and AI-based analytics for fully automated decision-making.Questions: How can automated technologies streamline machine data exchange between various departments in organizations? In what ways do AI-driven analytics improve the efficiency and effectiveness of decision-making processes using machine data? What impact do smart products have on decision-making and the users involved in operations? How do operational users accept this technology?
	External integration	Chatbots and smart products play a significant role in external integration. Indeed, process automation and the integration of multiple third-party suppliers are feasible options.Questions: What are the key strategies for effectively integrating smart products into an ecosystem with varying digital readiness levels? How crucial is the interaction between users and machines? Do employees understand the importance of continuous performance monitoring?

positively associated with reduced costs, increased efficiency, and enhanced experience. However, customer technology requirements must be met to fully realize these technologies' value. This raises questions regarding key processes of customer centricity, particularly customer integration, as well as internal and external integration. For example, how can B2B firms assess their internal readiness to integrate emerging technologies? Further, implementing digital product passports, for example, creates new opportunities for sustainable production across the supply chain, simultaneously raising unanswered research questions. Therefore, scholars should address how digital product passports can assist in sustainable decision-making and enhance transparency throughout the product life cycle. Successful integration and intense customer engagement with these technologies will create value for both the manufacturer and the customer firm. However, this entails data exchange between supply chain firms, introducing new avenues for further research in data security and integrity (e.g., Hofacker et al., 2020).

Third, *automated technologies* impact all key processes of customer centricity. For instance, automated technologies replace human interactions, thereby diminishing their importance in interactive CRM. However, knowledge regarding the potential negative impacts on relationships, specifically regarding the impact of AI, is limited. Alongside analyzing the immediate impact of replacing human interactions on relationships, attention should be given to studying the long-term effects. For example, automated technologies could weaken the manufacturer–customer firm relationship over time.

Introducing these emerging technologies in the B2B context and their applications in different organizational cultures, as well as at an international level, leads to promising opportunities for future research. We hope our sample of potential research questions motivates and inspires scholars.

5.4. Conclusions

Our study makes four contributions to the literature by developing the CC^{TECH}-framework and illustrating its use. Besides describing technologies pertinent to manufacturers, we categorized the technologies into several groups with similar characteristics. Finally, we outlined important research trajectories that scholars working in this dynamic field of research may find helpful. Our research agenda seeks to involve scholars and guide future research directions by addressing the proposed research questions.

CRediT authorship contribution statement

Nancy V. Wünderlich: Writing – review & editing, Writing – original draft, Project administration. **Markus Blut:** Writing – review & editing, Writing – original draft. **Christian Brock:** Writing – review & editing, Writing – original draft. **Nima Heirati:** Writing – review & editing, Writing – original draft. **Marcus Jensen:** Writing – review & editing, Writing – original draft. **Stefanie Paluch:** Writing – review & editing, Writing – original draft. **Julia Rötzmeier-Keuper:** Writing – review & editing, Writing – original draft. **Zsófia Tóth:** Writing – review & editing, Writing – original draft.

Declaration of competing interest

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Nancy V. Wünderlich is Professor and Chair of Digital Markets at Technische Universität Berlin, Germany. Her research encompasses consumer behavior in digital spaces, technology adoption and digital transformation challenges, and transformative service research. Her work is prominently featured in leading marketing and management journals, including the Journal of Consumer Research, Journal of the Academy of Marketing Science, Journal of Business Research, Journal of Product Innovation Management, Journal of Retailing, Journal of Service Research, and MIS Quarterly. Recognized for her outstanding contributions, she has received numerous prestigious awards in her field.

Markus Blut is Professor of Marketing at Durham University, UK. His primary areas of research interest are service management, retailing, and new technologies. He currently serves on the editorial review boards of Journal of Service Research (AE), Journal of Retailing, and Journal of Business Research. He published in leading journals, including the Journal of the Academy of Marketing Science, Journal of Product Innovation Management, Journal of Retailing, Journal of Service Research, International Journal of Research in Marketing, and Journal of the Association for Information Systems. His research has received international awards and nominations, such as the Best Article Award of the Journal of Service Research.

Christian Brock is Professor and Chair of Marketing at University of Rostock, Germany. His research interests are retail management and services marketing, specifically focusing on digital and sustainable transformation. Christian's work has been published in journals such as Journal of the Academy of Marketing Science, Journal of Product Innovation Management, Journal of Retailing, Journal of Service Research, International Journal of Research in Marketing, Psychology and Marketing, among others.

Nima Heirati is Associate Professor of Marketing at the University of Surrey. His research interests are innovation strategy, servitization, business relationships, customer experience, and the impact of artificial intelligence on consumer behavior. His work has been published in journals such as the Journal of Service Research, Industrial Marketing Management, and the Journal of Business Research, among others.

Marcus Jensen is a PhD student and member of the Marketing Research Group at the University of Rostock, Germany. He has a professional background as the Head of Digital Marketing at NORD DRIVESYSTEMS. His research focuses on B2B marketing, smart services, and digital transformation, effectively bridging academic theory and practical application in the industry.

Stefanie Paluch is Professor and Chair for Services and Technology Marketing at RWTH Aachen University. She is Research Fellow at King's Consumer and Organisation Data Analytics (CODA) Research Centre at King's College in London and Senior Fellow at the Centre for Relationship Marketing and Service Management, Hanken School of Economics, in Helsinki. Stefanie's research focuses on the challenges of digital transformation and the management of innovative technology-based services, e.g. service robots. She has received multiple awards in recognition of her contributions to the field and publishes her research in leading journals such as the Journal of Service Research, Journal of Business Research, Journal of Service Management, Journal of Service Marketing and the Journal of Service Theory and Practice.

Julia Rötzmeier-Keuper is a Postdoctoral researcher at the Digital Markets Research Group, Technische Universität Berlin, Germany. She received her PhD in Economics from Paderborn University, Germany. Her research interests include transformative consumer research with a focus on consumer vulnerability and well-being of marginalized consumer groups, as well as on the design and application of digital technologies to mitigate potential vulnerabilities in the marketplace. Her work has been published in the Journal of Consumer Research and the Journal of Business Research.

Zsófia Tóth is Associate Professor in Marketing and Management at Durham University, UK. Her primary areas of research interest are business networks and relationships, servitization, and the use of AI and digital marketing tools in B2B settings. She currently serves on the editorial review board of Industrial Marketing Management. She published in high quality journals, including the International Journal of Operations and Production Management, Industrial Marketing Management, and the Journal of Business Research. She received Distinguished Reviewer Award from Journal of Business Research.