Received: 3 August 2022 | Revised: 3 May 2023 | Accepted: 16 May 2023

DOI: 10.1111/jbl.12354

ORIGINAL ARTICLE

WILEY

Modularization of the front-end logistics services in e-fulfillment

Oznur Yurt[1,2] | **Metehan Feridun Sorkun**[3] | **Juliana Hsuan**[4]

[1]Department for People & Organisations, The Open University Business School, The Open University, London, UK

[2]Department of Logistics Management, Izmir University of Economics, İzmir, Türkiye

[3]Department of Business Administration, Izmir University of Economics, İzmir, Türkiye

[4]Department of Operations Management, Copenhagen Business School, Frederiksberg, Denmark

Correspondence
Metehan Feridun Sorkun, Department of Business Administration, Izmir University of Economics, İzmir, Türkiye.
Email: metehan.sorkun@ieu.edu.tr

Abstract

This study exploits service modularity in front-end logistics services in e-fulfillment, from a customer-centric approach, particularly in order management, delivery, and return. Through an online survey of UK customers, the service priorities of 494 respondents via AHP (Analytic Hierarchical Process) were analyzed. Extracting customers' service priorities, ordering behavior, and demographic information as input data, the clustering algorithm KAMILA (KAy-means for MIxed LArge data sets) was further applied. The three identified customer clusters (*multichannel shoppers, infrequent shoppers*, and *online fans*) provide preliminary evidence on how commonality and variability aspects of service modularity in front-end logistics services can optimize the number of service options and their performance levels. Therefore, our study, building on value co-creation and modularity, proposes a systematic way of exploiting service modularity for the customer segmentation process that addresses heterogeneous customer preferences cost-efficiently and uncomplicatedly. Furthermore, we provide a framework for the governance of front-end logistics services, guiding outsourcing decisions. Accordingly, it reveals the implications of customer priorities and service decomposition logic choices on value creation. Finally, the propositions formulated aim to develop theoretical foundations for explaining how the heterogeneity in customer priorities for logistics services can be managed with modularity, creating value both for customers and retailers.

KEYWORDS

customer-centric approach, e-fulfillment, front-end logistics services, service modularity, value co-creation

INTRODUCTION

Retailers are searching for customer-centric ways to offer superior services while keeping costs low (Castillo et al., 2022; Esper et al., 2020; Griffis et al., 2012). However, customer needs and demands are heterogeneous, and it is not always possible to satisfy all customers with the same level and type of services (Cho et al., 2022), making it challenging for retailers to create value in the eyes of the customers (Esper et al., 2003; Tokar et al., 2020). In e-fulfillment, that is, the delivery processes of online orders to customers (Lummus & Vokurka, 2002; Nguyen et al., 2018), the customization of services has become a critical tool for creating value for different customer groups and satisfying them (Nguyen et al., 2019). However, such efforts might also escalate costs if not used cautiously (Hu et al., 2016; Xing et al., 2011).

As customers' involvement in value creation (i.e., value co-creation) is essential (Kohtamäki & Rajala, 2016; Lusch et al., 2007) to increase customer satisfaction (Gligor & Maloni, 2022) and loyalty (Thiruvattal, 2017), the marketing literature is rich in the customer participation in the creation of offerings (Mustak et al., 2013). However, recent research has also begun to question the appropriate level of customer involvement (e.g., Gligor & Maloni, 2022) because too much of it could cause customer dissatisfaction, that is, value destruction (Plé & Chumpitaz Cáceres, 2010) due to service complexity and time waste (Gligor & Maloni, 2022; Sorkun et al., 2022). This could be particularly relevant for front-end logistics services, considering the difficulty for retailers to provide customers with enough incentive for their extensive involvement (Wang et al., 2019). Hence, what is needed is a relatively uncomplicated service offering that requires a reasonable amount of interaction with customers. A service system that is designed in a modular way could enable service customization at low costs and uncomplicatedly.

Modularity has been applied as a design strategy to tackle heterogeneous customer demand (Baldwin & Clark, 2000; Schilling, 2000; Voss & Hsuan, 2009). Similar to a physical product, a service offering, such as logistics services, can be partitioned into service modules that have clear functionality (Böttcher & Klingner, 2011), with each service module including service elements portraying the service characteristic (Pekkarinen & Ulkuniemi, 2008). In a modular service offering, service elements within the same module are highly interdependent, whereas the interdependencies between service elements across modules are low (Silander et al., 2017). This is ensured by well-established interfaces (Böttcher & Klingner, 2011). These features not only increase customization ability by recombining modules in different ways according to customer needs but also improve the ability to harness commonality by reusing modules in different offer variants, thereby providing cost-efficient service customization (Bask et al., 2010, 2011a; Johnson et al., 2021; Moon et al., 2011).

Given the limitations of standard logistics services in e-fulfillment in meeting different customer expectations (Van der Veeken & Rutten, 1998), service offerings tailored to the customers' priorities become crucial. Because it is the customers who determine the value of service provisions (Lusch et al., 2007), understanding customer priorities provides additional insights into service modularity. Service modularity increases the visibility of services, and therefore, facilitates customer participation in service co-creation (Rahikka et al., 2011; Ulkuniemi & Pekkarinen, 2011). Having better known what the proposed service is in advance, customers provide more relevant knowledge (operant resource) (Ranjan & Read, 2016; Saha et al., 2022), for example, what they value the most (Thiruvattal, 2017) when they interact with online retailers and/or logistics service providers (LSPs) at delivery and return pickup points, and in their phone calls and messages during order fulfillment. Online retailers can exploit this knowledge for better value propositions, accordingly. Demographic characteristics, such as the age and gender of targeted customers, also matter because online solutions can enhance the service experience for technology savvy customers. Therefore, in the context of front-end logistics services in e-fulfillment, customer priorities, their ordering behavior, and demographic characteristics can lead the modularization in service design because they guide the specific definition of interfaces.

It can be argued that many online retailers' logistics services are modular, as customers can reconfigure front-end logistics service elements (Bask et al., 2014). However, in itself, providing options (e.g., different delivery speed or return options) does not always bring the desired service outcomes (Hofman & Meijerink, 2015) because, if not chosen by customers after a careful assessment of the service value, these options can increase costs unnecessarily. For instance, providing the option of delivering items within hours might require the use of a new transportation mode and logistics partners. Further investment in these may not yield the expected increase in sales if a longer (e.g., three-day) delivery is acceptable by the customers. Therefore, the design of logistics services should incorporate customer analysis of those who have received the service (Van der Veeken & Rutten, 1998) through identifying an appropriate service architecture tailored to different customer segments (Pekkarinen & Ulkuniemi, 2008). Such analysis captures satisfactory performance in service elements prioritized by customers, while for the other elements, retaining standard performances can avoid unnecessary resource use (Mentzer et al., 2001). Hence, service modularity gives online retailers an opportunity of providing differentiated services while avoiding additional costs incurred from offering unnecessary options.

A cost-efficient and uncomplicated logistics service customization is important for online retailers, particularly for two reasons. First, although providing logistics service options is shown to enhance online shoppers' satisfaction (Hu et al., 2016; Xing et al., 2011), each additional option might entail a significant investment in infrastructure, equipment, and partners. Also, too many options may cause confusion and even dissatisfaction by overwhelming customers with too much information (Gligor & Maloni, 2022). Thus, it is of utmost importance for retailers to determine a proper service design architecture (e.g., the basic service level and the number of service levels offered for each service element) by considering the targeted customer portfolio. Second, online retailers often make value propositions with LSPs by conducting some of their logistics activities with them. However, this could escalate the required amount of interaction with LSPs and consequently erode the benefits for retailers if there remains a high level of interdependencies (due to customer prioritizations) between the service elements outsourced and conducted in-house (Baldwin, 2008). The service decomposition logic (Eissens-Van der Laan et al., 2016) can help online retailers to align service module boundaries with customer priorities. Hence, the need for too much interaction between online retailers and LSPs for the management of service processes can be avoided through a proper decomposition logic choice.

Motivated by the abovementioned challenges and opportunities, this study exploits service modularity in logistics services in e-fulfillment with varying customer priorities by posing the following research questions: How can service modularity be used (1) to determine a proper service design architecture by considering the targeted customer portfolio and (2) to define interfaces for front-end logistics services in e-fulfillment to create value both for customers and retailers? To address these questions, we conducted an empirical study with online customers in the United Kingdom and analyzed their logistics service priorities via the method of Analytic Hierarchical Process (AHP) that derives the priorities of decision criteria from paired comparisons (Saaty, 1987). The results of AHP, together with customers' ordering behavior and demographic characteristics, were used to identify customer clusters via the clustering algorithm KAMILA (Foss et al., 2016). Finally, a further statistical analysis of logistics preferences characterizing the customer clusters was conducted to formulate our propositions for value co-creation in the governance of front-end logistics services in e-fulfillment.

We contribute to the literature in four ways. First, we show a way of identifying a service architecture capable of meeting heterogeneous customer needs cost-efficiently and uncomplicatedly in service contexts, where providing additional service options might be costly for retailers and confusing for customers. Second, we reveal the implications of customer priorities and service decomposition choices on value creation/destruction in logistics service operations, guiding outsourcing decisions. We further remark on the potential handicaps of using the process-based decomposition logic in service modularization when it is not aligned with customer priorities. Third, with the aim of achieving service customization without any value destruction, we identify service elements for the standardization and management of interfaces. Fourth, our study introduces a novel way of measuring interdependencies between service elements and service process modules. This allows quantifying the degree of modularity in logistics services from the customer perspective.

The paper is structured as follows. The next section provides the theoretical background. Then, the following three sections outline the research design, present the findings, and formulate propositions for the governance of front-end logistics services in e-fulfillment, respectively. Finally, the last section presents the contributions and implications for both research and practice.

THEORETICAL BACKGROUND

Value co-creation versus value destruction in service customization

Service-dominant logic (Vargo & Lusch, 2004) puts focus on the exchange of services and particularly on customer needs. Retailers benefit from a clear understanding of the dynamic needs of customers, who are considered operant resources (Lusch et al., 2007). A better understanding of customer needs consequently enhances retailers' service operations performance (Jayaram & Xu, 2016) and competitiveness (Lusch et al., 2007). Herein, the design of delivery systems has gained importance in terms of their ability to address heterogeneous customer needs efficiently, also emphasized for logistics services (Yazdanparast et al., 2010). Customized logistics services in online retailing increase both customer satisfaction and costs (Hu et al., 2016; Xing et al., 2011). Service-dominant logic highlights the essentiality of customer involvement for customization, because without it, what's offered could be only a value proposition, not a value creation (Vargo & Lusch, 2016). However, the customer willingness for involvement may sometimes be low due to the lack of enjoyment/fun. If this is ignored, the service co-creation process might end with value destruction rather than value co-creation (Gligor & Maloni, 2022).

By involving customers in the value co-creation process, the service-dominant logic indeed aims at mass customization, which though, increases costs and operational complexity for retailers (Tokman & Beitelspacher, 2011). In such circumstances, partial mass customization could be preferred to full mass customization by postponing customer involvement (Squire et al., 2006). This strategy seems particularly proper for the front-end logistics services defined as "commoditized services" (Coltman & Devinney, 2013), for which customers do mainly prioritize a good operational performance such as price, consistency, and time sensitivity rather than seeking differentiation (Silvestro & Lustrato, 2015). Besides, given that logistics services do not include so much fun and enjoyment, customer involvement in them can be postponed (Wang et al., 2019). Hence, a menu-driven customization in which customers are allowed to customize the service with their choices among the available set of options might enable a postponed and cost-efficient mass customization for front-end logistics services if retailers can combine it with the reuse modularity that exploits the scale economies by performing the same service tasks for many customers (Silvestro & Lustrato, 2015).

Due to the cost and core competence concerns, retailers often outsource some of their logistics operations to LSPs. Hence, to meet customer needs, a retailer and an LSP should work together for value co-production nested in value co-creation (Hall et al., 2022; Sinkovics et al., 2018). This also implies a B2B relationship in which the retailer is the customer of the LSP company. As this B2B relationship is considered, the value creation depends on how LSP works collaboratively well with its customer, that is, the retailer. This collaborative work may range from just transmitting the retailer's needs and expectations to an LSP to the sharing of instantaneous data by the retailer's bringing their resources in the use of the LSP (e.g., customer information system) (Knemeyer et al., 2003). Although the collaboration increases the likelihood of value creation, the associated cost (the required amount of time and effort) could escalate and offset the benefits of collaboration. Therefore, to avoid this dark side of service co-production and co-creation processes, modularity could be used to improve outsourcing decisions (Baldwin, 2008). Accordingly, if different logistics service elements are considerably interdependent, for example, due to customer priorities, they should not be separated from each other by outsourcing because this would escalate the required amount of interaction, thus costs and efforts. Nevertheless, if outsourced, the firm has to reconfigure the location of service elements (i.e., the way of grouping them) or standardize interfaces between these groups/modules via modularization to reduce interdependencies, thereby lowering the respective costs due to too much interaction.

Modularity

Modularity is an approach to manage complex systems by partitioning (or decomposing) the systems into smaller portions, for example, subsystems/modules/components, so each portion can be managed independently (Baldwin & Clark, 2000; Tee et al., 2019). Modularization enables mixing-and-matching of components to create product variety and customization as a means to fulfill customer-specific needs and requirements (Hsuan & Persson, 2022). This is possible through standardized interfaces among components, hence modular components (Mikkola, 2006). Interfaces define how components interact (Mikkola & Gassmann, 2003; Sternberg & Denizel, 2021) and are important for two reasons. First, they prevent system failure (Peters et al., 2018) by ensuring the coordinated working of modules for the system's overall purpose (Voss & Hsuan, 2009). Second, standardized interfaces decrease interdependencies among components loosening the degree of coupling (Mikkola, 2006; Tee et al., 2019). Loose coupling makes the buy decision a viable option, as it lessens the required effort for coordination as an effort to define, measure and control the service content exchanged (Baldwin, 2008). It also brings the features of combinability and commonality, which provide both the ease of mixing-and-matching modules and the ability to reuse modules in many different final configurations enabling a cost-efficient realization of a wide range of needs (Baldwin & Clark, 2000; Gremyr et al., 2019).

Despite near consensus on the required properties of modular systems, there is no uniform way of measuring them. Existing measures mostly have a technical focus, which capture spatial, structural, material, and informative interactions/interdependencies among modules (Cabigiosu & Camuffo, 2016). The goal is to find the degree to which a system is suitable for partitioning into clear clusters of subassemblies. However, adopting such technical methods for determining the degree of module interdependencies has the risk of overlooking users' performance expectations. In essence, capturing user preferences can provide an indication of system performance and the corresponding interdependencies among modules, and the elements within these (Zirpoli & Becker, 2011).

Service modularity

Service modularity is an emerging research area (Frandsen, 2017), with scholarly efforts on establishing theoretical ground (de Mattos et al., 2021) and clearer definitions (Brax et al., 2017) by having been studied in various contexts, such as travel (Avlonitis & Hsuan, 2017; Voss & Hsuan, 2009), healthcare (de Blok et al., 2010; Sampson et al., 2015; Vähätalo & Kallio, 2015), human resources (Hofman & Meijerink, 2015), digital servitization (Hsuan et al., 2021), and e-learning (Sorkun et al., 2022).

Similar to product modularity in depicting the design of manufactured products (Brax et al., 2017), decomposition logic and interface are two important concepts in service modularity. Different decomposition logics can be used to partition complex service systems. Process- and outcome-oriented decomposition logics are two main ways of decomposing the service offering into modules by partitioning the service into processes needed for the service provision and what is provided to customers as service, respectively (Eissens-Van der Laan et al., 2016). Besides, interfaces in services, as defined by de Blok et al. (2014, p. 186), are "the set of rules and guidelines governing the flexible arrangement, interconnections, and interdependence of service components and service providers." The interfaces in service design architecture—for example, people, information, and rules—have a more human focus than those of manufactured products (Peters et al., 2018). In order to create value through service modularity via well-defined interfaces, it is critical to identify customer needs (Pekkarinen & Ulkuniemi, 2008). This leads to a better understanding of the strength of interdependencies between service modules and elements, which facilitates the definition of interfaces, and provides a smoother flow across service modules based on customer needs.

The need for customizing offerings to large masses entails economically viable solutions. The literature suggests that service modularity is an enabler of cost-efficient mass customization (Frandsen, 2017; Rajahonka & Bask, 2016). Commonality and combinability are important attributes of service modularity through which service providers can meet heterogeneous customer needs cost-efficiently. The set of service modules needed by service providers to meet customer requests constitutes the service platform (Voss & Hsuan, 2009). The higher the carry-over rate for service modules across customer orders, the greater efficiency via economies of scale (Rajahonka & Bask, 2016). Besides, the ease of mixing-and-matching modules is possible via standardized interfaces (Baldwin & Clark, 2000; Gremyr et al., 2019). Thus, a service provided to different customers in different contexts needs no major modifications to the service content (Pohjosenperä et al., 2019; Ulkuniemi & Pekkarinen, 2011). However, designing such systems in different service contexts remains an issue, and modularity can provide a solution (Spring & Araujo, 2009).

Modularity in logistics services

Modularity in logistics services has been widely researched, primarily with qualitative case study methods originating from the European context, as shown in Table 1. The prominent focus is on combinability and commonality, with service modularity as the vehicle to meet customers' various logistics service requirements, the reduction of complexity in operations (Bask et al., 2014), and the provision of efficiency in innovations (Rajahonka & Bask, 2016).

Bask et al. (2010) elaborate on how to exploit modularity in logistics services in e-commerce, arguing that, at customers' request, modularity can be used to provide additional services in the last-mile delivery (e.g., gift-wrapping). They remark that modularity allows logistics services to be diversified in terms of both performance (e.g., delivery speed ranging from standard delivery to overnight delivery) and customer preferences (e.g., delivery pickup location). Bask et al. (2014) specifically examine the order-delivery processes of e-stores, defining the order management, delivery, and return as modules, which can then further be decomposed into sub-processes and various options. They demonstrate that it is possible to tailor service solutions for customers by reconfiguring these options, and also that, by reusing modules in different customer orders, it is possible to achieve customization through a more efficient and simpler order fulfillment process. For future research, they suggest incorporating the customers' view into analysis to gain further insights into the modularization of the order-delivery process.

The customer segments for e-commerce buying behaviors and last-mile logistics preferences

As logistics services in e-fulfillment are provided to customers after their online purchases, the studies exploring the customer segments for e-commerce buying behaviors (e.g., De Keyser et al., 2015; Brand et al., 2020; Huseynov & Özkan Yıldırım, 2019) could hint at the preferences of different customer segments on front-end logistics services. In these studies, customer segments with some characteristics require much attention. First, while one group of customers mostly searches and purchases online (Brand et al., 2020; De Keyser et al., 2015), another group also purchases from store bricks-and-mortar stores besides from online stores (Nakano & Kondo, 2018; Herhausen et al., 2019; Brand et al., 2020). Additionally, cost, variety-seeking, and convenience (Atkins et al., 2016; Brand et al., 2020; Ganesh et al., 2010; Huseynov & Özkan Yıldırım, 2019; Rohm & Swaminathan, 2004) are shown as important factors that discriminate different groups of online customers. These factors are likely to be associated with their logistics service preferences. For example, if the cost is a priority in online purchases for a customer, it is also expected to have high importance in their delivery. Also notably, Barwitz and Maas (2018) segment online customers according to their value-in-use preferences and interaction choices. Accordingly, utilitarian customers, who aim to minimize their cost and sacrifice, would prefer relatively less interaction with sellers. However, customers seeking hedonic benefits would prefer more interaction. As the hedonic benefits related to front-end logistics services are considerably limited, customers are expected to show little interest in extensive interaction, highlighting

TABLE 1 The studies on modularity in logistics services.

Authors	Research unit/context	The stated goal of using modularity	Research method	Service modularity emphasis
Pekkarinen and Ulkuniemi (2008)	Finnish logistics service providers	Offering standard and tailored services to different customer markets without losing either the flexibility advantage of service differentiation or the cost advantage of standardization	Qualitative case study	A modular service platform in which different customer service applications can be easily developed by re-integrating the service modules
Bask et al. (2010)	Electronic business	Accomplishing flexibility and customization for different customers or situations in service implementation	Literature review	The usage of reusable process steps that can be combined
Lin et al. (2010)	Logistics service provider in China	Developing a modular logistics service platform to achieve service variety and to meet customized customer requirements	Qualitative case study	Rapid combinations of different service modules in the service platform
Bask et al. (2011b)	Finnish logistics service providers	Accomplishing flexibility to serve different customers and offer different services in the most efficient and profitable ways	Qualitative case study	A stable business model platform with customer- or situation-specific and interchangeable business model modules
Lin and Pekkarinen (2011)	Third-party logistics provider in China	Achieving higher customer service levels by providing and managing service variety to customers after identifying their requirements with QFD	Qualitative case study and QFD	A service platform that enables quickly (re) configuring and (re)combining services
Rajahonka (2013)	Finnish logistics service providers	Gaining competitive advantage by responding to the challenges, such as the increasingly diversified customer demands and more complex services, processes, and organizational networks	Qualitative case study	A basic service on which additional features can be added, or can be sold separately or combined into different service packages
Rajahonka et al. (2013)	Logistics service providers in Finland	Depends on the LSP provider's strategy (comprehensiveness of service offerings or customer relationships)	Qualitative case study	Commonality (the same service or service module's usability in many different service offerings) and combinability (changeability of service modules)
Bask et al. (2014)	Small- and medium-sized Finnish e-stores	Decreasing the complexity of the order-delivery process by offering a wide variety of familiar, well-known ordering, payment, delivery, and return options for the customers	Interpretative case study	Mixing-and-matching of various processes to create a variety of service offerings
Cabigiosu et al. (2015)	Third-party logistics providers in Italy	Allowing for customization in each service project	Qualitative case study	Offering bundles of services that are combinable with each other
Rajahonka and Bask (2016)	Finnish logistics service provider in automotive supply chain	Increasing efficiency in the innovation execution and adaption, as well as into the service model development process	Qualitative case study	Providing the same type of services for several customers by adding customer-specific modules (variations) to a rather standard platform service
Lubarski and Pöppelbuß (2017)	Logistics companies in Germany	A strategy to allow for both standardization and individualization at the same time so that customer-specific demands can be fulfilled efficiently	Qualitative case study	Standardizing processes
Pohjosenperä et al. (2019)	Finnish hospitals' healthcare logistics	Bringing well-being for employees, operational efficiencies, volume advantages, and coherence, which makes the operations and processes replicable to multiple customer units	Qualitative case study	Segmenting, categorizing, and unitizing offerings; differentiating and decoupling processes, and centralizing and specializing organizations
Wehner et al. (2021)	A waste service provider and two municipalities in Sweden	Facilitating environmentally sustainable development through visualization of potential energy efficiency improvement areas in logistics service provision	Qualitative case study	Applying the standardization principles of service modularity to the use of energy resources

the importance of a service delivery system creating value with a limited interaction in logistics services.

Although not many, a few studies segment customers according to their behaviors and preferences in last-mile logistics. Hjort et al. (2013) identify a group of customers systematically returning purchases. Wang et al. (2020) reveal different customer segments in the self-collection service for e-commerce deliveries, which show different amounts of willingness to receive orders from places different from home. Rai et al. (2021) examine the preferences of customers for crowdsourced last-mile logistics and reveal the characteristics of the segment willing to adopt the crowdsourced last-mile services and prefer home delivery. Vakulenko et al. (2022) compare urban and rural e-consumers and find that different service delivery options increase the satisfaction of only e-consumers from urban residential areas. To the best of our knowledge, the most comprehensive cluster analysis on customer preferences for last-mile logistics services is the study of Nguyen et al. (2019), which identifies "price-oriented," "time- and convenience-oriented," and "value-for-money-oriented" customer segments. Although Nguyen et al. (2019) and the other studies above are very useful for enhancing our understanding of how logistics services should be differentiated for different customer groups, none of them offers a systematic process that addresses heterogeneous customer preferences cost-efficiently and uncomplicatedly. Thus, the introduction of such process building on service modularity could make a solid contribution to this stream of studies.

The front-end logistics service elements in e-fulfillment

Front-end logistics services in e-fulfillment are crucial components of the last-mile logistics defined as "… the last stretch of business–consumer logistics, which spans the point of an item's assignment, no matter where (e.g., in store or at a fulfillment center), to a unique consumer until the point of consumption" (Hagberg & Hulthén, 2022). Thus, last-mile logistics also includes back-end operation processes invisible to consumers such as picking and warehousing of items (Bask et al., 2014). Compared with back-end operation processes, front-end logistics services are more critical for value co-creation as they require direct interaction with customers due to their visibility.

Customers can access offers for the same product from different online retailers, increasing the importance of logistics services performance in e-fulfillment. In addition, customers can influence the purchasing behaviors of others through their publicly visible ratings of logistics service elements, such as the online retailer's delivery time, packaging, return, and order management (Sorkun, 2019). Therefore, it is critical to be able to meet the heterogeneous service expectations with attractive value propositions (Heikka et al., 2018; Kawa & Światowiec-Szczepańska, 2021), which complements the customer segmentation view in logistics services (Mentzer et al., 2001; Nguyen et al., 2019). For example, those that prioritize delivery speed can be offered higher service levels, such as delivery overnight, on the same day, or within three business days (Bask et al., 2011b).

Order management, delivery, and return are three important processes in e-fulfillment (Bask et al., 2014; Nguyen et al., 2018). The delivery process for an online order critically affects customer's repurchasing behavior (Rao, Griffis, & Goldsby, 2011); speed, cost, and pickup point convenience are the three most important service elements (Nguyen et al., 2019). The return process is also very important because the number of return claims in online sales is often high mainly due to the impossibility of inspecting and trying on products before delivery (Sorkun, 2022). Return shipping cost, return processing time, and return convenience are the main service elements in this process. Order management is considered in parallel with delivery and return processes (Cristobal et al., 2007). The main related service elements are customized packaging, the status of cargo, and guidance to customers during the whole process (e.g., providing extra information about product and logistics processes) (Rao, Goldsby, et al., 2011; Wallenburg et al., 2021).

Based on these, it is possible to decompose front-end logistics services in e-fulfillment into the processes of order management, delivery, and return (Bask et al., 2014). Each of these processes can be further decomposed into service elements/outcomes. Building on Bask et al. (2014) framework on logistics-related modules and through multilevel decomposition logic (Eissens-Van der Laan et al., 2016), we conceptualize the front-end logistics service in e-fulfillment at two levels, as shown in Figure 1. In Level 1 (service modules), the front-end logistics service in e-fulfillment is decomposed into three service process modules: order management, delivery, and return. In Level 2 (service elements), each process module is decomposed into respective elements: order management (relational support, customized packaging, order tracking), delivery (delivery cost, delivery speed, pickup point convenience), and return (return shipping cost, return processing time, return convenience). Such decomposition logic enabled us to investigate service element pairs/triads that customers simultaneously prioritize and to capture the interdependence among service modules for the provision of satisfactory service. Our analysis indicates potential modularization areas based on these interdependencies. The descriptions of the elements are provided in Table 2.

RESEARCH DESIGN AND APPROACH

The research design is tailored to investigate customers' priorities on logistics service elements in e-fulfillment and service heterogeneity across customers. As Table 1 shows, most research on logistics service modularity has adopted the service provider perspective via qualitative research. Distinctively, we adopted a customer-centric approach to measure interdependencies between logistics service elements. Through an online survey of UK customers, we analyzed the service priorities of 494 respondents via AHP. Extracting customers' service priorities, ordering behavior, and demographic information as input data, we applied the clustering algorithm KAMILA and then conducted further statistical tests (t-tests) to reveal logistics preferences characterizing the customer clusters. Based on these findings, we finally formulated our propositions with the objective of developing theoretical foundations for explaining how the heterogeneity in customer priorities for logistics services should be used to design front-end logistics services via modularity that mutually creates value both for customers and retailers.

Data collection

UK was chosen as the setting of our empirical investigation, as it has the largest European B2C market (yStats.com, 2022). The survey data were collected via an online

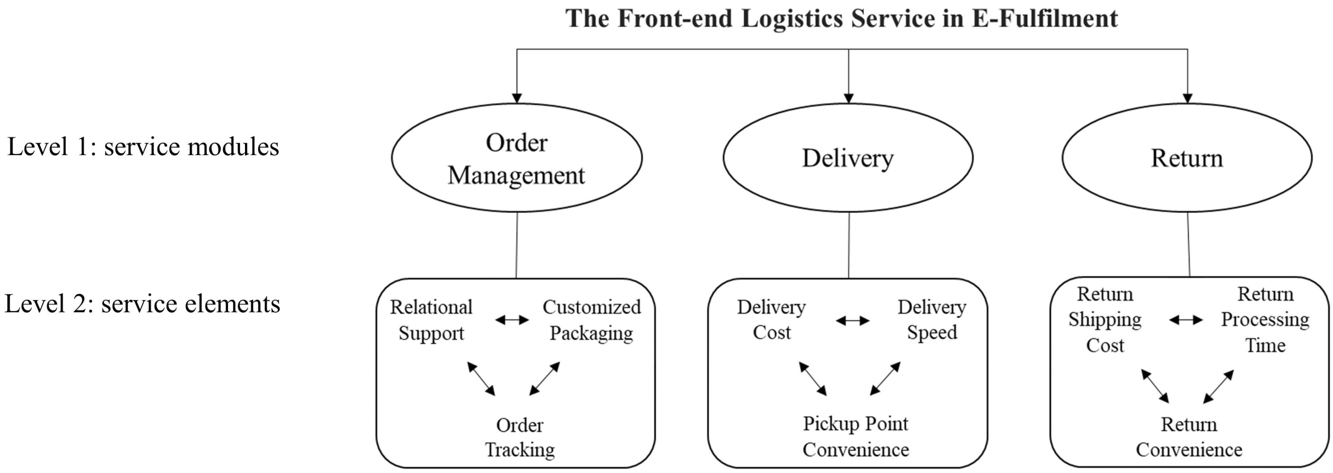

FIGURE 1 Modularized service design for the front-end logistics services in e-fulfillment.

TABLE 2 Description of the front-end logistics service elements in e-fulfillment.

Service module	Service element	Description
Order management	Relational Support	The assistance during the whole shopping process, including prepurchase (e.g., guidance on products), postpurchase (e.g., set-up instructions after product delivery)
	Customized packaging	The packaging options with respect to customer needs (e.g., standard, eco-friendly, gift packaging, extra protective packaging)
	Order tracking	The ability of tracking order (e.g., the frequency, richness, and the update speed of notifications on order status)
Delivery	Delivery cost	The fee paid for the delivery of items (e.g., free delivery, various cargo fees)
	Delivery speed	The length of time in which the ordered items are to be delivered (e.g., 4 h, same day, 3 business days)
	Pickup point convenience	The convenience of the location at which the customer receives the items (e.g., home, grocery, carrier's office)
Return	Return shipping cost	The fee paid for returning items (e.g., free return, various cargo fees.)
	Return processing time	The time period within which the return claim is to be resolved (e.g., same day, 1 week, 1 month)
	Return convenience	The time and effort spent for returned items (e.g., return pickup point convenience, the clarity of return procedure, the amount of paperwork required)

questionnaire. The questionnaire had three parts. The first part included 12 pairwise questions in which respondents indicate (on 1–9 AHP scale) how important they find each service module/element over another service module/element. Three questions requested a pairwise comparison between service process modules (i.e., order management, delivery, and return), and nine questions requested a comparison between service elements within the same service process module. The second part consisted of questions on ordering behavior, such as the monthly average number of online purchases, the amount spent, and the product categories purchased online. The final part included questions on demographic information.

The online questionnaire was administered by Qualtrics during February and March 2020. Qualtrics employs convenience sampling, but it leverages actively managed multiple sample sources. Their sampling system ensures the random selection of respondents from different sample sources, increasing the representability of the sampled dataset. Qualtrics gives respondents an incentive for participation, for example, cash, airline miles, or charitable donations.

Before the large-scale data collection, revisions and corrections were made after a pilot study with 43 customers to check the appropriateness of relevant service elements and to receive feedback. In the large-scale data collection, a filtering question excluded participants not considering themselves as online customers. IP restriction allowed access to UK residents only and responses of less than 6 min were automatically ignored to filter out nonattentive respondents. This led to 599 complete responses. Moreover, it was assumed that respondents were nonexperts whose responses might not provide a high level of consistency. Therefore, we sought preference transitivity (i.e., ordinal consistency) in responses, which simply requires that if A is preferred to B, A should then be preferred to C as well. Given that respondents make pairwise comparisons among a few variables in our AHP framework, responses violating the transitivity rule were considered to indicate a lack of attentiveness. After filtering out such responses, the final sample included 494 responses. Table 3 below shows the sample characteristics.

We checked the nonresponse bias to ensure the representativeness of our dataset via extrapolation, the most widely used technique for this operation in logistics research (Wagner & Kemmerling, 2010). We found no significant difference between the service prioritizations of early and late respondents, indicating no impact of nonresponse bias. Considering that a single self-report survey could cause common method bias, we applied some procedural remedies, such as presenting pairwise questions with a random order, promising the full anonymity of respondents, and receiving expert/academician opinions on the questionnaire design (Podsakoff et al., 2003). Furthermore, as a statistical control, we conducted Harmon's single factor test (Harman, 1967) on criteria and sub-criteria requested to be compared pairwise. We found that the total variance explained by no single criteria or sub-criteria (around 26%) is greater than 50%, decreasing the concerns for common method bias.

Cluster analysis

The literature emphasizes the importance of customer segmentation for differentiating logistics services in a cost-efficient way (Mentzer et al., 2001; Van der Veeken & Rutten, 1998). Clustering analysis can provide critical input on decisions on logistics service design while exploiting modularity. However, this application is underexplored in the front-end logistics services in e-fulfillment. Motivated by this research opportunity, we perform clustering analysis to identify customer groups with similar logistics service priorities, as well as consider their ordering behavior and demographic characteristics.

The data on the clustering of customers based on their priorities among the service elements were extracted via AHP (Saaty, 1987), a method for analyzing multi-criteria decision-making problems, including logistics problems (e.g., Jain & Khan, 2017). AHP enables comparison among different decision alternatives with respect to prespecified decision criteria. The best alternative depends on the priority weights of criteria, quantified through decision-makers' pairwise comparisons. However, with increasing numbers of criteria (i.e., the number of pairwise comparisons), demand on respondents' cognitive capacity might hamper reliable responses (Saaty & Ozdemir, 2003). For example, nine front-end logistics service elements compared pairwise means 72 pairwise comparisons. To reduce this cognitive effort, pairwise comparisons were carried out first between service process modules and then between service elements within the same process module, decreasing the number to 12. Next, the clustering analysis was performed using the importance weights of service elements extracted from AHP analysis, as well as the survey data on ordering behavior and demographic information of customers.

The 37 variables in our analysis constitute large mixed-type data of continuous variables (AHP importance weights) and categorical data (e.g., demographic information). Thus, we adopt the clustering algorithm KAMILA (Foss et al., 2016). This is particularly appropriate in our case for three reasons. First, in contrast to well-known clustering algorithms (e.g., k-means and hierarchical clustering), KAMILA can process large mixed-type data without the information loss caused by transforming nominal

TABLE 3 Sample characteristics.

Gender			*n* = 494
Female	57.9%	Male	42.1%
Marital status			
Married or civil partnership	59.9%	Single	38.5%
Prefer not to answer	1.6%		
Age			
18–24 years old	7.7%	25–34 years old	16.0%
35–44 years old	19.6%	45–54 years old	19.4%
55–64 years old	18.8%	65+ years old	18.4%
Education			
Less than high school degree	10.3%	High school degree or equivalent	32.2%
College or associate degree	19.0%	Bachelor's degree	27.1%
Master's degree	9.5%	PhD degree	1.8%
Occupation			
Full time employed	38.5%	Retired	20.6%
Part-time employed	11.5%	A homemaker	11.3%
Self-employed	6.7%	Student	1.4%
Unemployed	5.5%	Unable to work	4.5%
Avg. portion of online shopping in all expenses			
0%–20%	19.6%	21%–40%	32.0%
41%–60%	25.5%	61%–80%	16.8%
81%–100%	6.1%		
Avg. monthly number of online orders			
1–5 orders	53.2%	6–10 orders	24.1%
11–15 orders	8.3%	16–20 orders	5.1%
21+ orders	9.3%		
Avg. *monthly amount spent for online purchase*			
Less than 101£	41.3%	101–200£	26.1%
201–300£	12.8%	301–400£	5.1%
401–500£	6.7%	More than 500£	8.0%
% of respondents purchasing an item from a product category...			
Automotive	10.7%	Baby Products	9.7%
Books	48.0%	Clothing & Accessories	76.1%
Electronics & Accessories	56.5%	Flowers & Gifts	27.9%
Grocery & Food	39.5%	Health & Beauty	52.0%
Home & Kitchen	45.1%	Jewelry	25.5%
Movies & TV	32.2%	Office Products	19.4%
Pet Supplies	28.9%	Shoes	48.2%
Software & Mobile Applications	27.1%	Sports & Outdoors	24.7%
Tools & Home Improvement	27.9%	Toys & Games	35.6%

and categorical variables into a single type of variable. Second, KAMILA uses the semiparametric method and thus makes no parametric assumptions about the distribution of variables, such as normality. Finally, with KAMILA, the variable weights are not specified by the user, in contrast to the alternative methods (e.g., Gower distance (Gower, 1971) and dummy coding), in which the user-selected dummy values (e.g., 1) and weights inequitably determine the contribution of categorical variables to the results (Foss et al., 2016).

Users need to decide the number of clusters in partitioning clustering before the analysis, which leads to doubts over the appropriateness of a particular decision. Thus, we ran cross-validation (100 times) via KAMILA R-package (Foss & Markatou, 2018) and found that three is the optimal number of clusters according to the predictive power threshold 0.6 suggested by Foss et al. (2016). This predictive power dropped below 0.6 when we specified the number of clusters greater than 3. Furthermore, we also applied k-prototype (Huang, 1998) and partitioning around medoids (Kaufman & Rousseeuw, 1990) clustering algorithms to validate our optimal number of clusters. Validation indices in these algorithms, such as Tau and Ptbiserial (Szepannek, 2018), also showed that three is the most appropriate number of clusters.

For the triangulation of our clustering analysis, we also applied a Latent Class Analysis (LCA) to identify subgroups within a population based on the patterns of observed variables (Aflaki et al., 2022). Like KAMILA, LCA has been shown to perform well in clustering the mixed type of data (Preud'Homme et al., 2021). Thus, we utilized the latent Markov model, a type of LCA (Visser & Speekenbrink, 2010), to validate our findings. The analysis results (see Appendix 1) indicate that the number of three clusters is appropriate for our analysis, as it yields better model fit values than those of one and two latent class models. Besides, the sizes of the three classes are similar to the cluster sizes identified with KAMILA, and moreover, these classes are characterized by largely the same ordering behavior and demographic variables. Furthermore, we conducted the same statistical analysis on three customer classes of LCA to check if the ranking of logistics service prioritizations and their differences across customer groups conform with our findings obtained via KAMILA. The results of LCA support the clustering results of KAMILA in many ways (Appendix 1), enabling us to conclude that the heterogeneity in customer priorities for logistics services exists, and these can be exploited via service modularity.

FINDINGS

Table 4 shows the three clusters based on the customer's demographic characteristics and ordering behavior. Members of Cluster 1 are likely to be female, with a university or higher degree, and employed. Their high online shopping expenses are evidenced by the number of monthly online orders, but these are limited to a few particular product categories. For instance, a customer who buys products from 'clothing & accessories' and 'health & beauty' belongs to Cluster 1 with probabilities of more than 55%. The probabilities fall below 41% for all other categories, indicating that the online purchase of customers in Cluster 1 is limited to particular product categories. This implies intensive use of physical channesls for their other needs; therefore, we named Cluster 1 'multichannel shoppers'. An inference is that these people prefer searching for goods online in many product categories but tend to make in-store purchases.

Cluster 2 is likely to be customers over 55 years old, married or in a civil partnership, not employed, and without a university degree. They tend to shop online only for products from 'clothing & accessories' and 'electronics & accessories', as customers who make online purchases in other categories belong to Cluster 2 with a few probabilities (at most 44%). Although their online purchases limited to two product categories may imply their resemblance to *multichannel shoppers*, there is a salient difference that customers in Cluster 2 are likely to make fewer online orders and spend less. Furthermore, their portion of online shopping in all expenses does not most likely exceed 20%, indicating that they rarely use online channels for their purchases. Therefore, we named Cluster 2 'infrequent shoppers'.

Members of Cluster 3 are likely to be married or in a civil partnership, employed, and with a higher education degree. They are likely to buy a wider range of product categories online including 'books', 'clothing & accessories', 'electronics & accessories', 'flowers & gifts', 'grocery & food', 'health & beauty', 'home & kitchen', 'jewelry' 'movies & TV', 'pet supplies', 'shoes', 'software & mobile applications', 'sports & outdoor', 'tools & home improvement', and 'toys & games'. Cluster 3 members seem to prefer online shopping, given that, among all clusters, they are likely to spend the most, make the highest average number of online orders, and have the widest range of product categories. Thus, we named Cluster 3 'online fans'.

Table 5 shows the results of the cluster analysis. The percentages represent the prioritization given to each service element and service process module, where the percentage of each service process module is the subtotal of its service elements' percentages. The statistical tests (t-tests) in the table show the logistics service elements that characterize the customer clusters.

The analysis highlights four interesting results. First, the lack of variation between clusters in the priority of service process modules emphasizes the potential to exploit the commonality aspect of service modularity; for example, the delivery process is considerably important for all three clusters, and the return process for both *multichannel shoppers* and *online fans*.

Second, the service elements of order tracking and delivery cost are ranked as the most important in order management and delivery processes. For the return process, return convenience is an important service element for *multichannel shoppers* and *online fans*, and return shipping cost for *infrequent shoppers*.

TABLE 4 The results of cluster analysis for categorical variables.

Variable: category	The likelihood of being in a category Cluster 1 Multichannel shoppers (*n* = 166)	Cluster 2 Infrequent shoppers (*n* = 200)	Cluster 3 Online fans (*n* = 128)
Gender: Female	**61.85%**	53.91%	57.43%
Marital Status: Married or civil partnership	52.55%	**59.96%**	**67.41%**
Age: 18–24 years old	10.90%	5.43%	8.07%
Age: 25–34 years old	22.46%	6.62%	22.17%
Age: 35–44 years old	25.40%	8.61%	28.83%
Age: 45–54 years old	20.89%	17.06%	20.88%
Age: 55–64 years old	18.62%	**24.09%**	10.75%
Age: 65+ years old	1.73%	**38.18%**	9.29%
Education: University graduate or higher degree	**70.65%**	41.02%	**64.47%**
Occupation: Employed	**73.93%**	32.25%	**70.80%**
Avg. portion of online shopping in all expenses: 0%–20%	2.46%	**43.46%**	5.14%
Avg. portion of online shopping in all expenses: 21%–40%	33.24%	33.97%	25.89%
Avg. portion of online shopping in all expenses: 41%–60%	32.45%	16.88%	29.19%
Avg. portion of online shopping in all expenses: 61%–80%	24.83%	3.48%	27.35%
Avg. portion of online shopping in all expenses: 81%–100%	7.02%	2.22%	12.44%
Avg. monthly # of online orders: More than 5 orders	**60.35%**	17.23%	**75.30%**
Avg. monthly £ spent for online purchase: Less than 101£	18.92%	**72.43%**	21.05%
Avg. monthly £ spent for online purchase: 101–200£	35.12%	21.15%	23.22%
Avg. monthly £ spent for online purchase: 201£ and more	45.96%	6.42%	**55.74%**
Number of different product categories purchased online[a]	2	2	**15**
Product Category: Automotive	6.74%	8.34%	27.02%
Product Category: Baby Products	8.90%	5.55%	24.85%
Product Category: Books	33.95%	43.96%	**72.52%**
Product Category: Clothing & Accessories	**76.27%**	**63.20%**	**90.76%**
Product Category: Electronics & Accessories	36.45%	**51.11%**	**89.17%**
Product Category: Flowers & Gifts	23.87%	16.21%	**55.36%**
Product Category: Grocery & Food	40.26%	21.15%	**68.61%**
Product Category: Health & Beauty	**55.58%**	28.43%	**83.31%**
Product Category: Home & Kitchen	26.14%	37.89%	**81.58%**
Product Category: Jewelry	17.18%	14.76%	**57.37%**
Product Category: Movies & TV	25.68%	19.56%	**63.33%**
Product Category: Office Products	7.59%	15.96%	45.79%

TABLE 4 (Continued)

Variable: category	The likelihood of being in a category Cluster 1 Multichannel shoppers (*n* = 166)	Cluster 2 Infrequent shoppers (*n* = 200)	Cluster 3 Online fans (*n* = 128)
Product Category: Pet Supplies	18.95%	20.38%	**58.94%**
Product Category: Shoes	36.16%	30.62%	**90.91%**
Product Category: Software & Mobile Applications	16.68%	18.95%	**57.44%**
Product Category: Sports & Outdoors	12.19%	17.50%	**56.63%**
Product Category: Tools & Home Improvement	8.45%	24.04%	**63.13%**
Product Category: Toys & Games	28.55%	29.79%	**56.42%**

Note: The percentages indicate the likelihood that a customer in the respective cluster has certain characteristics, for example, there is a 61.85% probability that a customer in Cluster 1 is female.Values in bold indicate the characteristics of clusters only highlighted in the text.

[a]With more than 50% probability.

Third, a between-cluster comparison of the preference weights of each service process module and service element (*t*-tests in Table 5) shows that *multichannel shoppers* give less importance to order management, especially to the service elements of relational support and customized packaging. The results also demonstrate that *infrequent shoppers* prioritize the delivery process more mainly due to the delivery cost. Also notably, in the delivery process, the service element of delivery pickup point convenience is more important for *multichannel shoppers* than *online fans*. The results additionally show that the return process is less important for *infrequent shoppers* due to their less prioritizing return processing time and convenience.

Last, in terms of how to improve customer service experience via modularization, prioritized service element pairs/triads in different service process modules are examined across clusters. As such, satisfactory levels of all prioritized service elements are attained simultaneously, which implies a strong interdependency among these elements. Our results show that order tracking, delivery cost, and return shipping cost are significant service elements for all three clusters. Therefore, these prioritized service elements should be given special consideration in the design of the interfaces between service process modules, and any performance trade-off among them should be avoided.

DISCUSSION

Modularity is a powerful way to tackle the challenges of meeting individual needs in a cost-efficient and uncomplicated manner, yet, unfortunately, there is no straightforward way of achieving this goal. It is crucial to understand the role of interfaces in managing interdependencies and communication between modules (Voss & Hsuan, 2009). Due to the intangibility nature of services in modular service design, the inclusion of customer preferences can provide additional insights. We argue that interdependencies among service modules mainly arise from customers' particular preferences that are embedded in particular service elements. For a successful service provision, when these service elements are within different service process modules, the interfaces should also aim to ensure a simultaneously high level of performance, avoiding performance trade-offs. We show that segmenting customers, not only by their logistics service preferences but also by their demographic characteristics and ordering behavior, guides the definition of interfaces. Such segmentation allows for optimizing the number of service options and the related performance levels for cost-efficient and uncomplicated service customization, as well as informing outsourcing decisions not causing value destruction due to too much interaction.

Front-end logistics service elements can be decomposed into distinct service process modules (Bask et al., 2014) when modules are loosely coupled or interdependent. Within each process module, there are service elements that are linked together. Taken together, it is pertinent to identify the level of interdependencies between service elements in relation to different service process modules. Empirically measuring these interdependencies via AHP using the customer prioritizations allowed us to identify the service element pairs/triads required to deliver satisfactory performance levels. The designation of these prioritized service element pairs/triads within the task network provided guidance on how service elements can be dealt with, within and across process modules.

TABLE 5 The results of cluster analysis for the front-end logistics service modules and elements.

	Preference weights %				T-test		
	Cluster 1	Cluster 2	Cluster 3				
Service module & element	**Multichannel shoppers ($n = 166$)**	**Infrequent shoppers ($n = 200$)**	**Online fans ($n = 128$)**	**Total sample ($n = 494$)**	**Cluster 1 vs. Cluster 2**	**Cluster 1 vs. Cluster 3**	**Cluster 2 vs. Cluster 3**
Order management	22.52%	29.94%	27.00%	26.69%	−3.6388***	−1.9469*	1.3141
Relational support	5.46%	9.97%	8.51%	8.08%	−4.3476***	−2.5997***	1.1191
Customized packaging	4.16%	5.29%	5.55%	4.98%	−2.2118**	−2.1662**	−0.3960
Order tracking	12.90%	14.68%	12.94%	13.63%	−1.3481	−0.0294	1.3229
Delivery	40.53%	45.03%	37.34%	41.52%	−1.9889**	1.2994	3.3795***
Delivery cost	18.68%	23.88%	18.23%	20.67%	−3.0497***	0.2499	3.2436***
Delivery speed	11.40%	12.02%	10.86%	11.51%	−0.4676	0.3752	0.9237
Delivery pickup point conv.	10.45%	9.13%	8.25%	9.34%	1.093	1.7734*	0.7513
Return	36.95%	25.03%	35.64%	31.78%	4.7876***	0.4248	−3.9667***
Return shipping cost	14.40%	11.80%	14.45%	13.36%	1.9621*	−0.0339	−1.7807*
Return processing time	5.20%	4.16%	5.95%	4.97%	1.8552*	−0.8755	−2.2230**
Return convenience	17.35%	9.07%	15.24%	13.45%	4.8152***	0.9846	−3.5303***
The priority ranking of service process modules	1. Delivery 2. Return 3. Order man.	1. Delivery 2. Order man. 3. Return	1. Delivery 2. Return 3. Order man.	1. Delivery 2. Return 3. Order man.	***$p < .01$; **$p < .05$; *$p < .10$		

TABLE 6 The design of modular service architecture based on clustering analysis.

Service elements	The minimum preference weight among clusters	Standard basic service level[a]	Should different service levels be offered?[b]
Relational support	5.46%	Low	Yes
Customized packaging	4.16%	Low	Yes
Order tracking	12.90%	Medium	No
Delivery cost	18.23%	High	Yes
Delivery speed	10.86%	Medium	No
Delivery pickup point convenience	8.25%	Medium	No
Return shipping cost	11.80%	Medium	No
Return processing time	4.16%	Low	Yes
Return convenience	9.07%	Medium	Yes

[a]It is determined according to the overall mean (11.1%) and the standard deviation (4.9%) of all service element preference weights. Low service level < Mean—1 Standard deviation < Medium service level < Mean + 1 Standard deviation < High service level.

[b]It is determined according to the results of *t*-tests in Table 5. Different service levels should be offered if the service preference weight differences between any of the two clusters are significant at the level of $^{**}p < .05$.

Understanding the interfaces addressing interdependencies between these prioritized service element pairs/triads is an effective approach to modularizing the front-end logistics services in e-fulfillment.

> **Proposition 1.** *Customer priorities are a key to the modularization of front-end logistics services in e-fulfillment for cost-efficient service customization.*

Our findings provide preliminary evidence on how commonality and variability aspects of service modularity in front-end logistics services can be exploited to optimize the number of service options and their performance levels. Building on the results reported in Table 5, Table 6 shows the recommended threshold for a basic service level provided to meet the lowest level of prioritizations. If a service element's preference weight is low as in relational support and customized packaging (i.e., if it is lower than the overall mean by more than one standard deviation), this could be reflected in the basic service level offered. By contrast, if it is high, as in delivery cost (i.e., if it is higher than the overall mean by more than one standard deviation), this would demand a correspondingly high basic service level. After determining the basic service level, the variability of preference weights of service elements among the three clusters is considered. If the variation is low (i.e., no statistically significant difference exists among clusters), there is no need to offer different service levels (e.g., in delivery speed). But if considerable variation exists (i.e., a significant difference exists among clusters), different/alternative service levels may be needed (e.g., in delivery cost).

Our results show none of the three customer clusters prioritizes customized packaging in the order management process module or processing time in the return process module (see Table 5), suggesting that, for these service elements, cost efficiency can be obtained by providing a basic relatively low common standard service level to all clusters. Though, the basic standard service level should be relatively high for order tracking, delivery speed, pickup point convenience, and return shipping cost; because all customer clusters considerably prioritize these service elements; however, the lack of heterogeneity in customer preferences for them reduces the need to offer different service levels. By contrast, the prioritizations of relational support, customized packaging, delivery cost, return processing time, and return convenience by the customer clusters vary, implying the need for alternative service levels to address their particular priorities. A low standard/basic service level for relational support could be increased incrementally with other options. However, the standard/basic service level for delivery cost already indicates the need for a high service level. Therefore, even higher service levels may be required in line with customer expectations, for example, free long-distance delivery of large items.

> **Proposition 2.** *The degree and variety of customer prioritizations determine the number of service options and their basic performance levels, respectively, in cost-efficient service customization.*

The required variety and performance levels identified in Table 6 may influence outsourcing/governance decisions. Due to a lack of focus and resources, some service elements and their performance targets could be difficult to achieve for online retailers, making the outsourcing decision attractive. Nevertheless, we claim that the designation of these service elements within the task network should additionally be considered because they influence the amount of interaction required with LSPs, that is, coordination efforts, for a satisfactory service provision. For example, our findings indicate that return shipping cost and return convenience positioned within the same process are considerably prioritized by all customer clusters. Hence, outsourcing the whole return process could require relatively lower interaction. By contrast, delivery cost and order tracking are also prioritized service elements but are designated in different processes. Herein, outsourcing the delivery process could increase the amount of required interaction between online retailers and the LSP.

Proposition 3. *The prioritized service elements within different service process modules increase the required amount of interaction with LSPs.*

Our findings reveal that all customers, regardless of the cluster, prioritize particular service elements, that is, order tracking in order management module, cost in delivery module, and convenience and shipping cost in return module. Hence, well-defined interfaces between the service process modules should ensure the smooth flow of services to online customers through order management, delivery, and return processes, but with no performance compromise in the elements of order tracking, delivery cost, or return convenience & shipping cost.

Our findings show that delivery cost and return convenience are prioritized by *multichannel shoppers* and *online fans*. Interfaces should be specified to ensure both outcomes, for example, when retailers offer low delivery price (cost) or free delivery, a convenient return process should be maintained as a part of their service provision. In light of this, an effective way of defining an interface between delivery and return process modules could be to designate a small number of specific locations as delivery and return pickup points. For these customers, the delivery cost is important, and therefore they may be willing to pick up items from a specific place to save money. If the place is also chosen as the return pickup point, customers' familiarity with the location and the staff would increase the return convenience. Those in the clusters—*multichannel shoppers* and *online fans*—are generally employed; hence, they may find it convenient to pick up and return items to a place on their journey to or from work. *Infrequent shoppers* tend to be unemployed and purchase online infrequently, and prioritize the cost of delivery and return processes more than convenience. These also might be willing to travel to the few centrally-located designated pickup points if offered free delivery and return, despite potentially longer journeys from residential areas. As seen in these examples, as well as different customer prioritizations, demographic characteristics, and ordering behavior should also be considered when defining interfaces between service process modules.

Our findings show that, for *multichannel shoppers*, the prioritized service element pair is order tracking and return convenience, which are related to order management and return process modules, respectively. Here, technology could contribute to creating an appropriate interface ensuring high performance in these two service elements. For example, an innovative mobile application could allow customers to both track orders instantaneously and make return claims. The development of such application would allow customers to make a return claim even before delivery, providing a convenient return experience for customers who change their minds or notice an error in the order. As such, interfaces, which can take many different forms in terms of standards, rules, information, and technologies used (Peters et al., 2018), can ensure the smooth flow of services across order management, delivery, and return processes and yield high performance in the service elements prioritized by customers.

Proposition 4. *Standardizing interfaces, by addressing the prioritized service elements, leads to higher customer satisfaction and decreases the required amount of interaction with LSPs.*

Although we suggest several ways of standardizing interfaces between processes by addressing the prioritized service elements, this might not be possible for some online retailers due to technical constraints or contextual factors. In these circumstances, if outsourcing still seems an attractive option, online retailers could align the boundaries of modules with customer priorities by repositioning service elements. For instance, in our original conceptualization, the service element “order tracking” is in the order management process. If not possible to find a way to standardize the interface between order management and delivery process by addressing the prioritized service elements (order tracking and delivery cost), order tracking could be repositioned/shifted to the delivery process in the service design. As such, it is possible to outsource the order management process with its remaining service elements requiring a lower amount of interaction. If such repositioning is not possible, outsourcing is no longer an ideal alternative due to potential value destruction due to its requiring too much interaction.

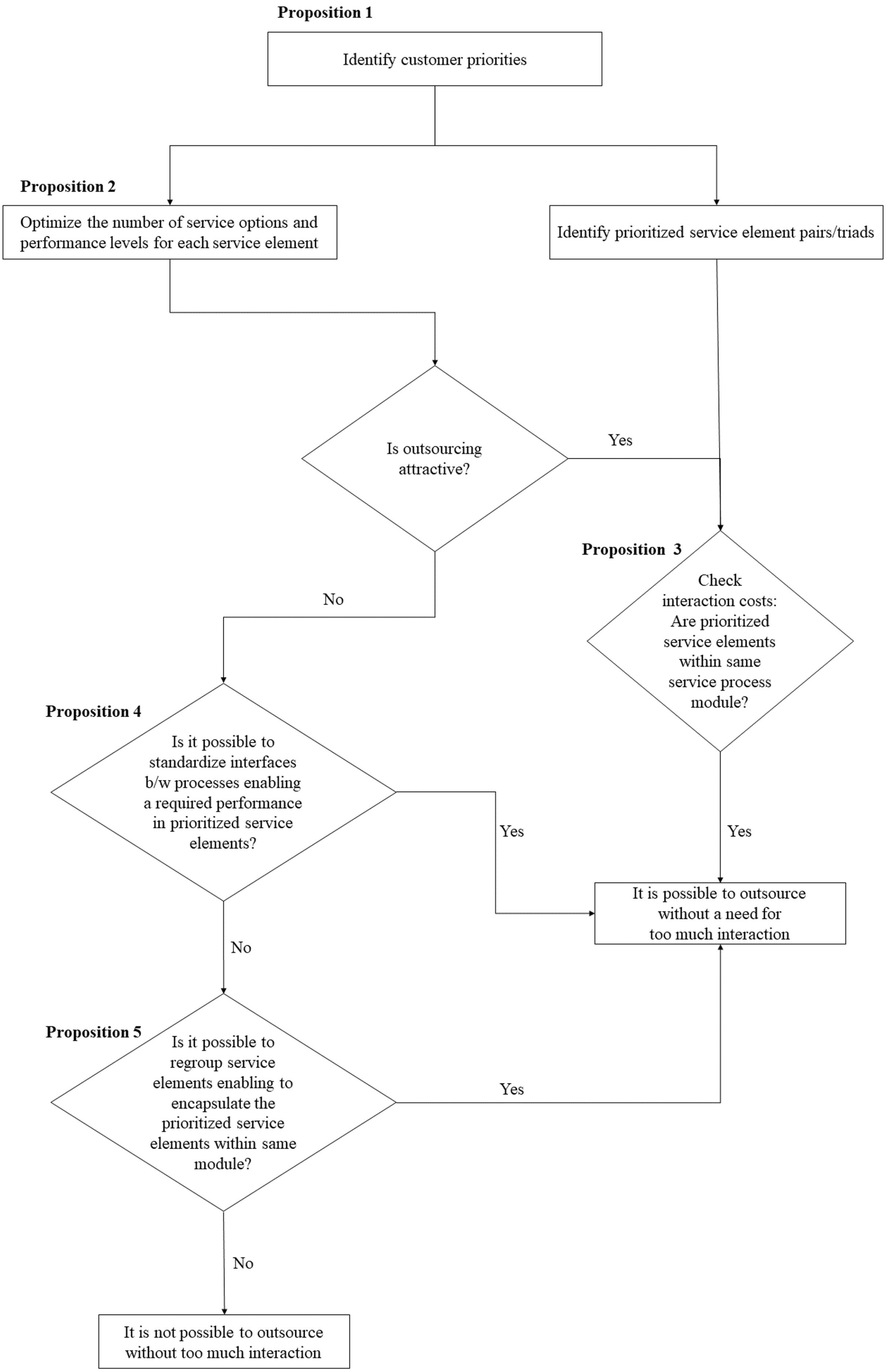

FIGURE 2 An overview framework for the governance of front-end logistics services in e-fulfillment.

Proposition 5. *If not possible to standardize interfaces by addressing the prioritized service elements, regrouping service elements in the way of encapsulating the prioritized service elements within the same module lowers the amount of required interaction.*

Figure 2 below demonstrates the overview framework for the governance of front-end logistics services in e-fulfillment.

CONCLUSIONS

Theoretical contributions and implications

This study, by adopting a customer-centric approach, exploits service modularity in front-end logistics services in e-fulfillment according to varying customer priorities. Through an empirical investigation in the United Kingdom on online customers' service priorities, it shows the way of identifying a service architecture capable of meeting heterogeneous customer needs cost-efficiently in contexts where offering additional service options can be costly and confusing. It also reveals the implications of customer priorities and service decomposition logic choices on value co-production and value co-creation, guiding outsourcing decisions. To achieve value co-creation, it identifies service elements for the standardization and management of interfaces.

This study contributes to the extant literature in four ways. First, we show the modularization of the front-end logistics services in e-fulfillment as an approach for addressing heterogeneous customer preferences cost-efficiently by offering service options aligned with different customer clusters' priorities. Moreover, our study draws on the idiosyncratic issue in the fulfillment of orders in online retailing, where offering additional logistics service options can be costly. This increases the importance of optimizing the number of service options and their performance levels for online retailers. This approach also proposes a value co-creation process for the type of services, such as front-end logistics services, in which customers are not so interested in participating in the service value creation process (Wang et al., 2019), and moreover, not so fond of having to choose among numerous options (Gligor & Maloni, 2022). Considering this, our approach is customer-centric because rather than aiming to adapt the existing service to different customer groups, it focuses on the development of service around the varying customer needs/priorities (Lamberti, 2013; Sheth et al., 2000) via an uncomplicated process that does not require a high level of customer involvement. Hence, our paper contributes to the literature by offering a conceptual "... tool that helps solve an empirical problem" (Boer et al., 2015, p. 1242).

Related to our first contribution, we introduce the systematic mechanism illustrating how modularity can be exploited for value creation in logistics services. Previous studies reveal the positive impact of service modularity on value creation in logistics services via single case studies by showing how modularity makes services visible (Ulkuniemi & Pekkarinen, 2011) and ensures customer involvement only in tasks for which customer willingness is high (Rahikka et al., 2011). However, it is not clear in these studies how modularity is deployed to this end. Our study depicts this mechanism at the micro-level and specifically shows how service options, in terms of their performance levels and variety only drawing the interest of customers, can be determined via modularity without a need for too much interaction with customers. This ensures a value co-creation process that is cost-efficient for online retailers and that is satisfactory and time/effort-saving for customers. Hence, we also indirectly propose a process preventing value destruction.

Second, we provide an overview framework for the governance of front-end logistics services in e-fulfillment that ensures value also for a service provider. Recent studies remark that value co-creation initiatives may carry negative valence (Hollebeek et al., 2019); therefore, they draw on the need for a mechanism/framework that helps firms assess the benefits and costs of a value co-creation partnership (Ranjan & Read, 2016; Saha et al., 2022). This is also critical in the provision of front-end logistics services in e-fulfillment because online retailers often aim to co-produce value with LSPs (Kohtamäki & Rajala, 2016). It is shown that the collaborative relationship with LSPs has positive effects on value creation (Sinkovics et al., 2018); however, we still need a more granular analysis for which service elements high collaboration/interaction is value-adding and for which it is not based on customer priorities. Otherwise, too much interaction with LSPs for not value-adding service elements could just erode the value for online retailers because of too much coordination effort/cost. We believe that our framework enhances the understanding of governance mode selections for online retailers via service modularity for achieving cost-efficient service customization without value destruction in its B2B relationship. The decrease in the degree of interaction is one proposed benefit of modularization (Sanchez & Mahoney, 1996; Sorkun & Furlan, 2017). Although this benefit was originally proposed for physical products, we adapted it to the provision of front-end logistics services in e-fulfillment.

Our empirical findings imply that a service decomposition logic choice (Eissens-Van der Laan et al., 2016) has implications on the required level of interaction. Most online retailers, as we do in our conceptual framework for empirical analysis, may modularize their logistics services using process-based decomposition logic assuming that service elements within the same process have a high level of interdependencies. However, this could escalate the amount of interaction if prioritized service element pair/triads within distinct processes create enduring interdependencies across service process modules. To avoid this, online retailers should either choose a decomposition logic that encapsulates the prioritized service elements into the same module or standardize interfaces between respective process modules by addressing the prioritized service elements.

Third, it is known that service modularity in general, and interfaces in particular, are critical research priorities in the operations management literature (de Blok et al., 2014; Voss & Hsuan, 2009). However, these concepts are not as well studied in logistics services from the customers' perspective. We propose that the critical aspects are the measurement methods for interdependencies between service elements and the definition of the interfaces between service process modules. Customer profiles incorporating their service priorities, demographic characteristics, and ordering behavior can form a basis for defining interfaces that ensure harmony between different service process modules, and thus, satisfactory service provision. Our study addresses this research gap by considering customer priorities and makes testable propositions for future research based on its empirical findings.

Fourth, our study provides theoretical insights into alternative ways of quantifying interdependencies between service elements and service process modules. Previous studies on logistics services modularity have adopted qualitative research to depict interfaces and the corresponding interdependencies among service modules (see Table 1). This approach is justified by the intangible nature of services and hence the difficulty in quantifying interdependencies between service modules. Our study, by contrast, shows that interdependencies can be quantified through alternative means, such as customer prioritizations.

Taken as a whole, our main contribution to this study is to propose a systematic way of exploiting service modularity for the customer segmentation process that addresses heterogeneous customer preferences cost-efficiently and uncomplicatedly. Therefore, rather than predicting the reactions of customers in different clusters to front-end logistics services provided (which should be surely investigated by future research), we propose a process that takes customer priorities as the main input. Hence, we believe that our findings, that is, the process, can be generalizable to other populations and service contexts. The same process can be applied to different populations and even to other types of services that are decomposable and show similarity with front-end logistics services in terms of the level of customer willingness to participate in the service co-creation process. Furthermore, our propositions based on our clustering analysis guide the outsourcing decisions of retailers for value creation. All these can be tested by future research in different populations. Also from this aspect, our study contributes by developing theoretical foundations for explaining the heterogeneity in customer priorities for logistics services and how this heterogeneity managed by modularity can create value for customers and retailers.

Managerial implications

Our study proposes an approach to modularizing the front-end logistics services in e-fulfillment via a customer-centric approach, which can be easily implemented by retailers. Based on customer preferences, managers can measure the level of interdependencies between service elements within distinct service process modules, enabling them to identify highly interdependent service processes and service elements, and thus, to determine a focus for their modularization efforts. The modularization process, driven by customer preferences, would bring not only greater operational efficiency but also more satisfactory service provision. This would require managers to define interfaces across service process modules, considering customer profiles in terms of their service priorities, demographic characteristics, and ordering behavior.

Moreover, our findings provide managerial guidance on how to exploit service modularity for the cost-efficient customization of logistics services. Similar importance is attached to some (but not all) service elements across all customer groups according to our empirical results. This provides the opportunity of exploiting the commonality and combinability features of service modularity via a service architecture design, that is, determining how many service performance levels to offer for each service element and at which performance levels. For example, according to Table 5, it would be sufficient to offer a standard acceptable service performance level for service elements (e.g., return processing time) not prioritized by any of the customer clusters, while customization of the service according to customer needs would be appropriate for service elements given different priorities across customer clusters (e.g., return convenience).

Our study also provides managerial implications for retailers on whether, and if so, when to outsource some logistics service processes to LSPs. Building on core competence and scale efficiency arguments, it is rather straightforward for retailers to make outsourcing decisions of logistics service processes in e-fulfillment. However, with the strong interdependence of service elements within different service processes due to customer preferences, outsourcing the respective service processes can dramatically increase the amount of interaction, which could erode the benefits of outsourcing. Nevertheless, the customer-centric approach addressing the prioritized service element pairs for interface standardization can enable an extensive decoupling of service process modules, making it possible to outsource respective service process modules with a reasonable amount of interaction.

Our findings finally provide managerial insights into how managers could collaborate with customers and other supply chain network members to co-create value. As we emphasized, due to low customer willingness to participate in the value co-creation regarding logistics service processes, online retailers need to implement strategies to learn customer priorities/preferences without bothering customers. Herein, employees can obtain customer priorities quickly at delivery and return pickup points while interacting with customers. Retailers can also collaborate with other supply chain network members to know customers better. For example, the customers of online retailers could probably be the customers of LSPs due to their other online transactions or personal cargo shipments. Thus, information sharing between online retailers and other supply chain network members can provide a better knowledge of customers, yielding superior value propositions. More importantly, after being better informed about customer priorities, our approach indicates the needed collaboration areas among supply chain network members that can create value for customers. For instance, retailers can work with LSPs on mobile applications that jointly enable better order tracking and more convenient pickup at delivery/return points. Alternatively, collaborating with the packaging company can deliver better solutions addressing customers' costs and packaging concerns if prioritized simultaneously.

Limitations and future research directions

Our study is not without limitations. The validity of our results can be questioned due to their being based on a single survey. Though, the other studies' findings provide a kind of external validity. For instance, online customer groups— utilitarian customers in Barwitz and Maas (2018), price-oriented customers in Nguyen et al. (2019), and web-focused shoppers in De Keyser et al. (2015) carry similar characteristics to those of our study, which are *multichannel shoppers, infrequent shoppers*, and *online fans*, respectively. Also, the findings of the recent e-commerce research are consistent with our sample and cluster characteristics. For example, the most purchased product category in Europe, as in our sample, is stated as clothing (Lone & Weltevreden, 2022). The research on UK consumers (RetailX, 2021) also shows similarities with our clusters in terms of the relationships between demographic characteristics and shopping behavior. For instance, people over 55 mostly spend a few amount in their online shopping and are interested in clothing (RetailX, 2021).

The other limitation could be that our questionnaire focuses on the customers' overall service preferences in multiple industries, rather than specific industries, such as textile, grocery, and digital products, each of which may show a particular variation in customers' logistics preferences and ordering behavior. Another limitation is the application of the service element prioritizations in relative percentages rather than absolute numbers, making it difficult to argue that the percentage difference for the same service element across customer clusters reflects proportionally the difference in the expected actual service performance on the ground. For instance, the importance of delivery cost for *infrequent shoppers* is approximately 5% greater than for the other two clusters, yet a particular delivery shipping fee might satisfy all three. Additionally, we acknowledge that the performance expectation in service elements (e.g., delivery cost or delivery speed) might not correspond to the same performance level for different product categories, for example, customers might be willing to pay more for or wait longer for the delivery of home products compared with clothing products. In this manner, it is essential to consider the product category while defining interfaces between service modules.

Further research could expand our analysis into new levels, for example, by extending the list of logistics service elements to include future practices in unattended delivery and ordering, for example, "wardrobing." Also, the role of delivery time window in fulfillment (Boyer et al., 2009) can be included in future research in different contexts. Studying these service elements also in non-European contexts could enhance the understanding of the applicability of modularity in logistics services in e-fulfillment.

ORCID

Oznur Yurt https://orcid.org/0000-0003-1510-5844
Metehan Feridun Sorkun https://orcid.org/0000-0002-9699-4243
Juliana Hsuan https://orcid.org/0000-0003-3084-6288

REFERENCES

Aflaki, K., Vigod, S., & Ray, J. G. (2022). Part I: A friendly introduction to latent class analysis. *Journal of Clinical Epidemiology*, *147*, 168–170. https://doi.org/10.1016/j.jclinepi.2022.05.008

Atkins, K. G., Kumar, A., & Kim, Y. K. (2016). Smart grocery shopper segments. *Journal of International Consumer Marketing*, *28*(1), 42–53. https://doi.org/10.1080/08961530.2015.1082080

Avlonitis, V., & Hsuan, J. (2017). Exploring modularity in services: Cases from tourism. *International Journal of Operations & Production Management*, *37*(6), 771–790. https://doi.org/10.1108/IJOPM-08-2015-0531

Baldwin, C. Y. (2008). Where do transactions come from? Modularity, transactions, and the boundaries of firms. *Industrial and Corporate Change*, *17*(1), 155–195. https://doi.org/10.1093/icc/dtm036

Baldwin, C. Y., & Clark, K. B. (2000). *Design rules: The power of modularity*. MIT Press.

Barwitz, N., & Maas, P. (2018). Understanding the omnichannel customer journey: Determinants of interaction choice. *Journal of Interactive Marketing*, *43*, 116–133. https://doi.org/10.1016/j.intmar.2018.02.001

Bask, A., Lipponen, M., Rajahonka, M., & Tinnilä, M. (2010). The concept of modularity: Diffusion from manufacturing to service production. *Journal of Manufacturing Technology Management*, *21*(3), 355–375. https://doi.org/10.1108/17410381011024331

Bask, A., Lipponen, M., Rajahonka, M., & Tinnilä, M. (2011a). Framework for modularity and customization: Service perspective. *Journal of Business & Industrial Marketing*, *26*(5), 306–319. https://doi.org/10.1108/08858621111144370

Bask, A., Lipponen, M., Rajahonka, M., & Tinnilä, M. (2011b). Modularity in logistics services: A business model and process view. *International Journal of Services and Operations Management*, *10*(4), 379–399.

Bask, A., Merisalo-Rantanen, H., & Tuunanen, T. (2014). Developing a modular service architecture for E-store supply chains: The small-and medium-sized enterprise perspective. *Service Science*, *6*(4), 251–273. https://doi.org/10.1287/serv.2014.0082

Boer, H., Holweg, M., Kilduff, M., Pagell, M., Schmenner, R., & Voss, C. (2015). Making a meaningful contribution to theory. *International Journal of Operations & Production Management*, *35*(9), 1231–1252. https://doi.org/10.1108/IJOPM-03-2015-0119

Böttcher, M., & Klingner, S. (2011). Providing a method for composing modular B2B services. *Journal of Business & Industrial Marketing*, *26*(5), 320–331. https://doi.org/10.1108/08858621111144389

Boyer, K. K., Prud'homme, A. M., & Chung, W. (2009). The last mile challenge: Evaluating the effects of customer density and delivery window patterns. *Journal of Business Logistics*, *30*, 185–201. https://doi.org/10.1002/j.2158-1592.2009.tb00104.x

Brand, C., Schwanen, T., & Anable, J. (2020). 'Online Omnivores' or 'Willing but struggling'? Identifying online grocery shopping behavior segments using attitude theory. *Journal of Retailing and Consumer Services*, *57*, 102195. https://doi.org/10.1016/j.jretconser.2020.102195

Brax, S. A., Bask, A., Hsuan, J., & Voss, C. (2017). Service modularity and architecture–an overview and research agenda. *International Journal of Operations & Production Management*, *37*(6), 686–702. https://doi.org/10.1108/IJOPM-03-2017-0191

Cabigiosu, A., Campagnolo, D., Furlan, A., & Costa, G. (2015). Modularity in KIBS: The case of third-party logistics service providers. *Industry and Innovation*, *22*(2), 126–146. https://doi.org/10.1080/13662716.2015.1023012

Cabigiosu, A., & Camuffo, A. (2016). Measuring modularity: Engineering and management effects of different approaches. *IEEE Transactions on Engineering Management*, *64*(1), 103–114. https://doi.org/10.1109/TEM.2016.2614881

Castillo, V. E., Bell, J. E., Mollenkopf, D. A., & Stank, T. P. (2022). Hybrid last mile delivery fleets with crowdsourcing: A systems view of managing the cost-service trade-off. *Journal of Business Logistics*, *43*(1), 36–61. https://doi.org/10.1111/jbl.12288

Cho, W., Min, D.-J., & Dresner, M. (2022). The impact of predicted quality and customer cost on quality assurance behavior. *International Journal of Operations & Production Management*, *42*(4), 409–439. https://doi.org/10.1108/IJOPM-07-2021-0456

Coltman, T., & Devinney, T. M. (2013). Modeling the operational capabilities for customized and commoditized services. *Journal of Operations Management*, *31*(7–8), 555–566. https://doi.org/10.1016/j.jom.2013.09.002

Cristobal, E., Flavián, C., & Guinalíu, M. (2007). Perceived e-service quality (PeSQ): Measurement validation and effects on consumer satisfaction and web site loyalty. *Managing Service Quality: An International Journal*, *17*(3), 317–340. https://doi.org/10.1108/09604520710744326

de Blok, C., Luijkx, K., Meijboom, B., & Schols, J. (2010). Modular care and service packages for independently living elderly. *International Journal of Operations & Production Management*, *30*(1), 75–97. https://doi.org/10.1108/01443571011012389

de Blok, C., Meijboom, B., Luijkx, K., Schols, J., & Schroeder, R. (2014). Interfaces in service modularity: A typology developed in modular health care provision. *Journal of Operations Management*, *32*(4), 175–189. https://doi.org/10.1016/j.jom.2014.03.001

De Keyser, A., Schepers, J., & Konuş, U. (2015). Multichannel customer segmentation: Does the after-sales channel matter? A replication and extension. *International Journal of Research in Marketing*, *32*(4), 453–456. https://doi.org/10.1016/j.ijresmar.2015.09.005

de Mattos, C. S., Fettermann, D. C., & Cauchick-Miguel, P. A. (2021). Service modularity: Literature overview of concepts, effects, enablers, and methods. *The Service Industries Journal*, *41*(15–16), 1–22. https://doi.org/10.1080/02642069.2019.1572117

Eissens-Van der Laan, M., Broekhuis, M., van Offenbeek, M., & Ahaus, K. (2016). Service decomposition: A conceptual analysis of modularizing services. *International Journal of Operations & Production Management*, *36*(3), 308–331. https://doi.org/10.1002/joom.1007

Esper, T. L., Castillo, V. E., Ren, K., Sodero, A., Wan, X., Croxton, K. L., Knemeyer, A. M., DeNunzio, S., Zinn, W., & Goldsby, T. J. (2020). Everything old is new again: The age of consumer-centric supply chain management. *Journal of Business Logistics*, *41*, 286–293. https://doi.org/10.1111/jbl.12267

Esper, T. L., Jensen, T. D., Turnipseed, F. L., & Burton, S. (2003). The last mile: An examination of effects of online retail delivery strategies on consumers. *Journal of Business Logistics*, *24*, 177–203. https://doi.org/10.1002/j.2158-1592.2003.tb00051.x

Foss, A., Markatou, M., Ray, B., & Heching, A. (2016). A semiparametric method for clustering mixed data. *Machine Learning*, *105*(3), 419–458. https://doi.org/10.1007/s10994-016-5575-7

Foss, A. H., & Markatou, M. (2018). Kamila: Clustering mixed-type data in R and hadoop. *Journal of Statistical Software*, *83*(13), 1–45. https://doi.org/10.18637/jss.v083.i13

Frandsen, T. (2017). Evolution of modularity literature: A 25-year bibliometric analysis. *International Journal of Operations & Production Management*, *37*(6), 703–747. https://doi.org/10.1108/IJOPM-06-2015-0366

Ganesh, J., Reynolds, K. E., Luckett, M., & Pomirleanu, N. (2010). Online shopper motivations, and e-store attributes: An examination of online patronage behavior and shopper typologies. *Journal of Retailing*, *86*(1), 106–115. https://doi.org/10.1016/j.jretai.2010.01.003

Gligor, D. M., & Maloni, M. J. (2022). More is not always better: The impact of value co-creation fit on B2B and B2C customer satisfaction. *Journal of Business Logistics*, *43*(2), 209–237. https://doi.org/10.1111/jbl.12278

Gower, J. C. (1971). A general coefficient of similarity and some of its properties. *Biometrics*, *27*(4), 857–871. https://doi.org/10.2307/2528823

Gremyr, I., Valtakoski, A., & Witell, L. (2019). Two routes of service modularization: Advancing standardization and customization. *Journal of Services Marketing*, *33*(1), 73–87. https://doi.org/10.1108/JSM-10-2018-0285

Griffis, S. E., Rao, S., Goldsby, T. J., Voorhees, C. M., & Iyengar, D. (2012). Linking order fulfillment performance to referrals in online retailing: An empirical analysis. *Journal of Business Logistics*, *33*, 279–294. https://doi.org/10.1111/jbl.12002

Hagberg, J., & Hulthén, K. (2022). Consolidation through resourcing in last-mile logistics. *Research in Transportation Business & Management*, *45*, 100834. https://doi.org/10.1016/j.rtbm.2022.100834

Hall, K. K. L., Richey, R. G., Jr., & Patil, R. K. (2022). Collaboration, feedback, and performance: Supply chain insights from service-dominant logic. *Journal of Business Research*, *146*, 385–397. https://doi.org/10.1016/j.jbusres.2022.03.055

Harman, D. (1967). A single factor test of common method variance. *Journal of Psychology*, *35*, 359–378.

Heikka, E.-L., Frandsen, T., & Hsuan, J. (2018). Matching value propositions with varied customer needs: The role of service modularity. *Knowledge and Process Management*, *25*(1), 64–73. https://doi.org/10.1002/kpm.1556

Herhausen, D., Kleinlercher, K., Verhoef, P. C., Emrich, O., & Rudolph, T. (2019). Loyalty formation for different customer journey segments. *Journal of Retailing*, *95*(3), 9–29. https://doi.org/10.1016/j.jretai.2019.05.001

Hjort, K., Lantz, B., Ericsson, D., & Gattorna, J. (2013). Customer segmentation based on buying and returning behaviour. *International Journal of Physical Distribution & Logistics Management*, *43*(10), 852–865. https://doi.org/10.1108/IJPDLM-02-2013-0020

Hofman, E., & Meijerink, J. (2015). Platform thinking for services: The case of human resources. *The Service Industries Journal*, *35*(3), 115–132. https://doi.org/10.1080/02642069.2014.989999

Hollebeek, L. D., Srivastava, R. K., & Chen, T. (2019). SD logic–informed customer engagement: Integrative framework, revised fundamental propositions, and application to CRM. *Journal of the Academy of Marketing Science*, *47*(1), 161–185. https://doi.org/10.1007/s11747-016-0494-5

Hsuan, J., Jovanovic, M., & Clemente, D. H. (2021). Exploring digital servitization trajectories within product-service-software space. *International Journal of Production & Operations Management*, *41*(5), 598–621. https://doi.org/10.1108/IJOPM-08-2020-0525

Hsuan, J., & Persson, M. (2022). Servitization, modularity, and innovation in supply chain management. In J. Sarkis (Ed.), *The Palgrave Handbook of Supply Chain Management*. Palgrave Macmillan. https://doi.org/10.1007/978-3-030-89822-9_88-1

Hu, M., Huang, F., Hou, H., Chen, Y., & Bulysheva, L. (2016). Customized logistics service and online shoppers' satisfaction: An empirical study. *Internet Research*, *26*(2), 484–497. https://doi.org/10.1108/IntR-11-2014-0295

Huang, Z. (1998). Extensions to the k-means algorithm for clustering large data sets with categorical values. *Data Mining and Knowledge Discovery*, *2*(3), 283–304. https://doi.org/10.1023/A:1009769707641

Huseynov, F., & Özkan Yıldırım, S. (2019). Online consumer typologies and their shopping behaviors in B2C e-commerce platforms. *SAGE Open*, *9*(2), 2158244019854639. https://doi.org/10.1177/2158244019854639

Jain, V., & Khan, S. A. (2017). Application of AHP in reverse logistics service provider selection: A case study. *International Journal of Business Innovation and Research*, *12*(1), 94–119. https://doi.org/10.1504/IJBIR.2017.080711

Jayaram, J., & Xu, K. (2016). Determinants of quality and efficiency performance in service operations. *International Journal of Operations & Production Management*, *36*(3), 265–285. https://doi.org/10.1108/IJOPM-03-2014-0122

Johnson, M., Roehrich, J. K., Chakkol, M., & Davies, A. (2021). Reconciling and reconceptualising servitization research: Drawing on modularity, platforms, ecosystems, risk and governance to develop mid-range theory. *International Journal of Operations & Production Management*, *41*(5), 465–493. https://doi.org/10.1108/IJOPM-08-2020-0536

Kaufman, L., & Rousseeuw, P. J. (1990). *Finding groups in data*. Wiley.

Kawa, A., & Światowiec-Szczepańska, J. (2021). Logistics as a value in e-commerce and its influence on satisfaction in industries: A multilevel analysis. *Journal of Business & Industrial Marketing*, *36*(13), 220–235. https://doi.org/10.1108/JBIM-09-2020-0429

Knemeyer, A. M., Corsi, T. M., & Murphy, P. R. (2003). Logistics outsourcing relationships: Customer perspectives. *Journal of Business Logistics*, *24*(1), 77–109. https://doi.org/10.1002/j.2158-1592.2003.tb00033.x

Kohtamäki, M., & Rajala, R. (2016). Theory and practice of value co-creation in B2B systems. *Industrial Marketing Management*, *56*, 4–13. https://doi.org/10.1016/j.indmarman.2016.05.027

Lamberti, L. (2013). Customer centricity: The construct and the operational antecedents. *Journal of Strategic Marketing*, *21*(7), 588–612. https://doi.org/10.1080/0965254X.2013.817476

Lin, Y., Luo, J., & Zhou, L. (2010). Modular logistics service platform. In *Proceedings of 2010 IEEE International Conference on Service Operations and Logistics, and Informatics* (pp. 200–204). IEEE. https://doi.org/10.1109/SOLI.2010.5551582

Lin, Y., & Pekkarinen, S. (2011). QFD-based modular logistics service design. *Journal of Business & Industrial Marketing*, *26*(5), 344–356. https://doi.org/10.1108/08858621111144406

Lone, S., & Weltevreden, J. W. J. (2022). *2022 European E-commerce Report*. Amsterdam University of Applied Sciences & Ecommerce Europe.

Lubarski, A., & Pöppelbuß, J. (2017). Modularization of logistics services—An investigation of the status quo. In M. Freitag, H. Kotzab, & J. Pannek (Eds.), *Dynamics in logistics* (pp. 413–422). Springer.

Lummus, R. R., & Vokurka, R. J. (2002). Making the right e-fulfillment decision. *Production and Inventory Management Journal*, *43*(1/2), 50–55.

Lusch, R. F., Vargo, S. L., & O'brien, M. (2007). Competing through service: Insights from service-dominant logic. *Journal of Retailing*, *83*(1), 5–18. https://doi.org/10.1016/j.jretai.2006.10.002

Mentzer, J. T., Flint, D. J., & Hult, G. T. M. (2001). Logistics service quality as a segment-customized process. *Journal of Marketing*, *65*(4), 82–104. https://doi.org/10.1509/jmkg.65.4.82.18390

Mikkola, J. H. (2006). Capturing the degree of modularity embedded in product architectures. *Journal of Product Innovation Management*, *23*, 128–146. https://doi.org/10.1111/j.1540-5885.2006.00188.x

Mikkola, J. H., & Gassmann, O. (2003). Managing modularity of product architectures: Toward an integrated theory. *IEEE Transactions on Engineering Management*, *50*(2), 204–218. https://doi.org/10.1109/TEM.2003.810826

Moon, S. K., Shu, J., Simpson, T. W., & Kumara, S. R. (2011). A module-based service model for mass customization: Service family design. *IIE Transactions*, *43*(3), 153–163. https://doi.org/10.1080/07408171003705383

Mustak, M., Jaakkola, E., & Halinen, A. (2013). Customer participation and value creation: A systematic review and research implications. *Managing Service Quality: An International Journal*, *23*(4), 341–359. https://doi.org/10.1108/MSQ-03-2013-0046

Nakano, S., & Kondo, F. N. (2018). Customer segmentation with purchase channels and media touchpoints using single source panel data. *Journal of Retailing and Consumer Services*, *41*, 142–152. https://doi.org/10.1016/j.jretconser.2017.11.012

Nguyen, D. H., de Leeuw, S., Dullaert, W., & Foubert, B. P. (2019). What is the right delivery option for you? Consumer preferences for delivery attributes in online retailing. *Journal of Business Logistics*, *40*(4), 299–321. https://doi.org/10.1111/jbl.12210

Nguyen, D. H., de Leeuw, S., & Dullaert, W. E. (2018). Consumer behaviour and order fulfilment in online retailing: A systematic review. *International Journal of Management Reviews*, *20*(2), 255–276. https://doi.org/10.1111/ijmr.12129

Pekkarinen, S., & Ulkuniemi, P. (2008). Modularity in developing business services by platform approach. *The International Journal of Logistics Management*, *19*(1), 84–103. https://doi.org/10.1108/09574090810872613

Peters, V. J. T., Meijboom, B. R., & De Vries, E. (2018). Interfaces in service modularity: A scoping review. *International Journal of Production Research*, *56*(20), 6591–6606. https://doi.org/10.1080/00207543.2018.1461270

Plé, L., & Chumpitaz Cáceres, R. C. (2010). Not always co-creation: Introducing interactional co-destruction of value in service-dominant logic. *Journal of Services Marketing*, *24*(6), 430–437. https://doi.org/10.1108/08876041011072546

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, *88*(5), 879–903. https://doi.org/10.1037/0021-9010.88.5.879

Pohjosenperä, T., Kekkonen, P., Pekkarinen, S., & Juga, J. (2019). Service modularity in managing healthcare logistics. *The International Journal of Logistics Management*, *30*(1), 174–194. https://doi.org/10.1108/IJLM-12-2017-0338

Preud'Homme, G., Duarte, K., Dalleau, K., Lacomblez, C., Bresso, E., Smaïl-Tabbone, M., Couceiro, M., Devignes, M.-D., Kobayashi, M., Huttin, O., Ferreira, J. P., Zannad, F., Rossignol, P., & Girerd, N. (2021). Head-to-head comparison of clustering methods for heterogeneous data: A simulation-driven benchmark. *Scientific Reports*, *11*, 4202. https://doi.org/10.1038/s41598-021-83340-8

Rahikka, E., Ulkuniemi, P., & Pekkarinen, S. (2011). Developing the value perception of the business customer through service modularity. *Journal of Business & Industrial Marketing*, *26*(5), 357–367. https://doi.org/10.1108/08858621111144415

Rai, H. B., Verlinde, S., & Macharis, C. (2021). Who is interested in a crowdsourced last mile? A segmentation of attitudinal profiles. *Travel Behaviour and Society*, *22*, 22–31. https://doi.org/10.1016/j.tbs.2020.08.004

Rajahonka, M. (2013). Views of logistics service providers on modularity in logistics services. *International Journal of Logistics Research and Applications*, *16*(1), 34–50. https://doi.org/10.1080/13675567.2013.767325

Rajahonka, M., & Bask, A. (2016). The development of outbound logistics services in the automotive industry: A logistics service provider's view. *The International Journal of Logistics Management*, *27*(3), 707–737. https://doi.org/10.1108/IJLM-08-2012-0082

Rajahonka, M., Bask, A., & Lipponen, M. (2013). Modularity and customization in LSPs' service strategies. *International Journal of Services and Operations Management*, *16*(2), 174–204. https://doi.org/10.1504/IJSOM.2013.056165

Ranjan, K. R., & Read, S. (2016). Value co-creation: Concept and measurement. *Journal of the Academy of Marketing Science*, *44*, 290–315. https://doi.org/10.1007/s11747-014-0397-2

Rao, S., Goldsby, T. J., Griffis, S. E., & Iyengar, D. (2011). Electronic logistics service quality (e-LSQ): Its impact on the customer's purchase satisfaction and retention. *Journal of Business Logistics*, *32*(2), 167–179. https://doi.org/10.1111/j.2158-1592.2011.01014.x

Rao, S., Griffis, S. E., & Goldsby, T. J. (2011). Failure to deliver? Linking online order fulfillment glitches with future purchase behavior. *Journal of Operations Management*, *29*(7–8), 692–703.

RetailX. (2021). *United Kingdom 2021 Ecommerce Country Report*. https://retailx.net/product/uk-2021-ecommerce-country-report/ Accessed 25 November 2022.

Rohm, A. J., & Swaminathan, V. (2004). A typology of online shoppers based on shopping motivations. *Journal of Business Research*, *57*(7), 748–757. https://doi.org/10.1016/S0148-2963(02)00351-X

Saaty, R. W. (1987). The analytic hierarchy process—what it is and how it is used. *Mathematical Modelling*, *9*(3–5), 161–176. https://doi.org/10.1016/0270-0255(87)90473-8

Saaty, T. L., & Ozdemir, M. S. (2003). Why the magic number seven plus or minus two. *Mathematical and Computer Modelling*, *38*(3–4), 233–244. https://doi.org/10.1016/S0895-7177(03)90083-5

Saha, V., Goyal, P., & Jebarajakirthy, C. (2022). Value co-creation: A review of literature and future research agenda. *Journal of Business & Industrial Marketing*, *37*(3), 612–628. https://doi.org/10.1108/JBIM-01-2020-0017

Sampson, S. E., Schmidt, G., Gardner, J. W., & Van Orden, J. (2015). Process coordination within a health care service supply network. *Journal of Business Logistics*, *36*, 355–373. https://doi.org/10.1111/jbl.12106

Sanchez, R., & Mahoney, J. T. (1996). Modularity, flexibility, and knowledge management in product and organization design. *Strategic Management Journal*, *17*(S2), 63–76. https://doi.org/10.1002/smj.4250171107

Schilling, M. A. (2000). Toward a general modular systems theory and its application to interfirm product modularity. *Academy of Management Review*, *25*(2), 312–334. https://doi.org/10.2307/259016

Sheth, J. N., Sisodia, R. S., & Sharma, A. (2000). The antecedents and consequences of customer-centric marketing. *Journal of the Academy of Marketing Science*, *28*, 55–66. https://doi.org/10.1177/0092070300281006

Silander, K., Torkki, P., Lillrank, P., Peltokorpi, A., Brax, S. A., & Kaila, M. (2017). Modularizing specialized hospital services: Constraining characteristics, enabling activities and outcomes. *International Journal of Operations & Production Management*, *37*(6), 791–818. https://doi.org/10.1108/IJOPM-06-2015-0365

Silvestro, R., & Lustrato, P. (2015). Exploring the "mid office" concept as an enabler of mass customization in services. *International Journal of Operations & Production Management*, *35*(6), 866–894. https://doi.org/10.1108/IJOPM-03-2013-0154

Sinkovics, R. R., Kuivalainen, O., & Roath, A. S. (2018). Value co-creation in an outsourcing arrangement between manufacturers and third party logistics providers: Resource commitment, innovation and collaboration. *Journal of Business & Industrial Marketing*, *33*(4), 563–573. https://doi.org/10.1108/JBIM-03-2017-0082

Sorkun, M. F. (2019). The impact of product variety on LSQ in e-marketplaces. *International Journal of Physical Distribution & Logistics Management*, *49*(7), 749–766. https://doi.org/10.1108/IJPDLM-06-2018-0223

Sorkun, M. F. (2022). Commercial Product returns: Emerging trends via network analysis. In A. P. Lopes (Ed.), *Cases on supply chain management and lessons learned from COVID-19* (pp. 86–118). IGI Global.

Sorkun, M. F., & Furlan, A. (2017). Product and organizational modularity: A contingent view of the mirroring hypothesis. *European Management Review*, *14*(2), 205–224. https://doi.org/10.1111/emre.12101

Sorkun, M. F., Yurt, O., & Hsuan, J. (2022). Service modularity in e-learning programs: An analysis from the perceived usefulness perspective. *International Journal of Operations & Production Management*, *42*(5), 637–660. https://doi.org/10.1108/IJOPM-09-2021-0598

Spring, M., & Araujo, L. (2009). Service, services and products: Rethinking operations strategy. *International Journal of Operations & Production Management*, *29*(5), 444–467. https://doi.org/10.1108/01443570910953586

Squire, B., Brown, S., Readman, J., & Bessant, J. (2006). The impact of mass customisation on manufacturing trade-offs. *Production and Operations Management*, *15*(1), 10–21. https://doi.org/10.1111/j.1937-5956.2006.tb00032.x

Sternberg, H. S., & Denizel, M. (2021). Toward the physical internet—Logistics service modularity and design implications. *Journal of Business Logistics*, *42*, 144–166. https://doi.org/10.1111/jbl.12261

Szepannek, G. (2018). clustMixType: User-friendly clustering of mixed-type data in R. *The R Journal*, *10*(2), 200–208. https://doi.org/10.32614/RJ-2018-048

Tee, R., Davies, A., & Whyte, J. (2019). Modular designs and integrating practices: Managing collaboration through coordination and cooperation. *Research Policy*, *48*(1), 51–61. https://doi.org/10.1016/j.respol.2018.07.017

Thiruvattal, E. (2017). Impact of value co-creation on logistics customers' loyalty. *Journal of Global Operations and Strategic Sourcing*, *10*(3), 334–361. https://doi.org/10.1108/JGOSS-11-2016-0034

Tokar, T., Williams, B. D., & Fugate, B. S. (2020). I heart logistics—Just don't ask me to pay for it: Online shopper behavior in response to a delivery carrier upgrade and subsequent shipping charge increase. *Journal of Business Logistics*, *41*, 182–205. https://doi.org/10.1111/jbl.12239

Tokman, M., & Beitelspacher, L. S. (2011). Supply chain networks and service-dominant logic: Suggestions for future research. *International Journal of Physical Distribution & Logistics Management*, *41*(7), 717–726. https://doi.org/10.1108/09600031111154152

Ulkuniemi, P., & Pekkarinen, S. (2011). Creating value for the business service buyer through modularity. *International Journal of Services and Operations Management*, *8*(2), 127–141. https://doi.org/10.1504/IJSOM.2011.038569

Vähätalo, M., & Kallio, T. J. (2015). Organising health services through modularity. *International Journal of Operations & Production Management*, *35*(6), 925–945. https://doi.org/10.1108/IJOPM-12-2013-0523

Vakulenko, Y., Arsenovic, J., Hellström, D., & Shams, P. (2022). Does delivery service differentiation matter? Comparing rural to urban e-consumer satisfaction and retention. *Journal of Business Research*, *142*, 476–484. https://doi.org/10.1016/j.jbusres.2021.12.079

Van der Veeken, D. J., & Rutten, W. G. (1998). Logistics service management: Opportunities for differentiation. *The International Journal of Logistics Management*, *9*(2), 91–98. https://doi.org/10.1108/09574099810805861

Vargo, S. L., & Lusch, R. F. (2004). Evolving to a new dominant logic for marketing. *Journal of Marketing*, *68*(1), 1–17. https://doi.org/10.1509/jmkg.68.1.1.24036

Vargo, S. L., & Lusch, R. F. (2016). Institutions and axioms: An extension and update of service-dominant logic. *Journal of the Academy of Marketing Science*, *44*(1), 5–23. https://doi.org/10.1007/s11747-015-0456-3

Visser, I., & Speekenbrink, M. (2010). depmixS4: An R package for hidden Markov models. *Journal of Statistical Software*, *36*(7), 1–21. https://doi.org/10.18637/jss.v036.i07

Voss, C. A., & Hsuan, J. (2009). Service architecture and modularity. *Decision Sciences*, *40*(3), 541–569. https://doi.org/10.1111/j.1540-5915.2009.00241.x

Wagner, S. M., & Kemmerling, R. (2010). Handling nonresponse in logistics research. *Journal of Business Logistics*, *31*(2), 357–381. https://doi.org/10.1002/j.2158-1592.2010.tb00156.x

Wallenburg, C. M., Einmahl, L., Lee, K.-B., & Rao, S. (2021). On packaging and product returns in online retail—Mailing boxes or sending signals? *Journal of Business Logistics*, *42*(2), 291–308. https://doi.org/10.1111/jbl.12273

Wang, X., Wong, Y. D., Teo, C. C., Yuen, K. F., & Feng, X. (2020). The four facets of self-collection service for e-commerce delivery: Conceptualisation and latent class analysis of user segments. *Electronic Commerce Research and Applications*, *39*, 100896. https://doi.org/10.1016/j.elerap.2019.100896

Wang, X., Yuen, K. F., Wong, Y. D., & Teo, C. C. (2019). Consumer participation in last-mile logistics service: An investigation on cognitions and affects. *International Journal of Physical Distribution & Logistics Management*, *49*(2), 217–238. https://doi.org/10.1108/IJPDLM-12-2017-0372

Wehner, J., Altuntas Vural, C., & Halldórsson, Á. (2021). Energy efficiency in logistics through service modularity: The case of household waste. *International Journal of Physical Distribution & Logistics Management*, *51*(1), 76–94. https://doi.org/10.1108/IJPDLM-08-2019-0267

Xing, Y., Grant, D. B., McKinnon, A. C., & Fernie, J. (2011). The interface between retailers and logistics service providers in the online market. *European Journal of Marketing*, *45*(3), 334–357. https://doi.org/10.1108/03090561111107221

Yazdanparast, A., Manuj, I., & Swartz, S. M. (2010). Co-creating logistics value: A service-dominant logic perspective. *The International Journal of Logistics Management*, *21*(3), 375–403. https://doi.org/10.1108/09574091011089808

yStats.com. (2022). *Europe B2C Ecommerce Market 2022*. https://ystats.com/shop/europe-b2c-e-commerce-market-2022/ Accessed 25 April 2022.

Zirpoli, F., & Becker, M. C. (2011). The limits of design and engineering outsourcing: Performance integration and the unfulfilled promises of modularity. *R&D Management*, *41*(1), 21–43. https://doi.org/10.1111/j.1467-9310.2010.00629.x

AUTHOR BIOGRAPHIES

Dr. Oznur Yurt is a senior lecturer in Operations & Supply Chain at the Open University, United Kingdom, and an adjunct professor of Marketing and Supply Chain Management at Izmir University of Economics, Turkey. Her research interests include service supply chains, buyer–supplier relations, and food supply chains. Her work has been published by several journals such as International Journal of Operations & Production Management and Journal of Business Research.

Metehan Feridun Sorkun is an associate professor of Operations & Supply Chain Management at Izmir University of Economics. His research focuses on modularity, logistics services, order fulfillment, product innovation, and waste management. His research has appeared in the International Journal of Operations and Production Management, Industrial Marketing Management, International Journal of Physical Distribution & Logistics Management, Waste Management, and other peer-reviewed journals and book chapters.

Juliana Hsuan is a professor of Operations & Supply Chain Management at Copenhagen Business School (CBS) and an affiliated professor at Chalmers University of Technology. She is the concentration coordinator of CBS MSc SCM. Her research interests include (service) operations management, (circular) SCM, servitization, innovation/R&D management, modularity, and mass customization. Her research has been published in leading academic journals including IJOPM, JPIM, PP&C, SCMIJ, DSJ, IEEE TEM, and Technovation, among others.

How to cite this article: Yurt, O., Sorkun, M. F., & Hsuan, J. (2023). Modularization of the front-end logistics services in e-fulfillment. *Journal of Business Logistics*, *00*, 1–26. https://doi.org/10.1111/jbl.12354

APPENDIX 1

Further explanations in Table A1:

Table A1 shows that Latent Class Analysis (LCA) supports the findings of KAMILA in many ways. First, the three-class model shows a better model fit than the one-class and two-class models. Besides, the sizes of classes are like those of clusters identified with KAMILA. The LCA results are also largely consistent regarding the commonalities and differences between service preferences across customer clusters. The delivery process is considerably prioritized by all three clusters. The return process is again found important for Cluster 1 and 3 members but not for Cluster 2 members who prioritize order management over the return process. LCA similarly shows that some service elements within the same service process are prioritized (e.g., order tracking) and deprioritized (e.g., return processing time) by all three clusters. The *t*-test results in Table A1 also provide evidence that many logistics service element preferences characterize the customer clusters, and these are considerably consistent regardless of the clustering method applied. The consistently found insignificant differences (e.g., delivery speed and relational support) also indicate the potential exploitation of commonality in the modular service design of logistics services in e-fulfillment. To conclude, Table A1 demonstrates that the statistical test results on the outcomes of LCA and KAMILA are quite consistent, and the ranking of prioritizations given by three clusters to service elements is completely robust except for the cases that the preference weights of two clusters are very close to each other, for example, the weights of return shipping cost in Cluster 1 (12.27%) and in Cluster 2 (12.92%). We additionally would like to note that ordering behavior and demographic variables characterizing three clusters are consistent across KAMILA and LCA, such as Cluster 1 members who have a high number of online orders but are limited to few particular categories, Cluster 2's relatively older, not employed, and without university degree members who make very few online orders and spend the least, and Cluster 3 members who spend the most with the highest number of online orders from a wide range of product categories.

TABLE A1 The triangulation of our cluster analysis via latent class analysis.

Service module & element	Preference weights %				*T*-test		
	Cluster 1	Cluster 2	Cluster 3				
	Multichannel shoppers ($n = 143$)	Infrequent shoppers ($n = 256$)	Online fans ($n = 95$)	Total sample ($n = 494$)	Cluster 1 vs. Cluster 2	Cluster 1 vs. Cluster 3	Cluster 2 vs. Cluster 3
Order management	12.93%	33.43%	29.22%	26.69%	**−14.243*** **	**−7.4264*** **	*1.7241* *
Relational support	2.73%	10.42%	9.79%	8.08%	**−9.7847*** **	**−5.6609*** **	**0.4405**
Customized packaging	3.10%	5.77%	5.65%	4.98%	**−5.9549** **	**−3.8557*** **	**0.16925**
Order tracking	7.09%	17.23%	13.77%	13.63%	*−10.801****	*−5.1525****	*2.3155***
Delivery	40.98%	44.36%	34.66%	41.52%	*−1.4611*	*2.3721***	**4.3118*** **
Delivery cost	9.86%	27.73%	17.89%	20.67%	**−14.782*** **	−5.2949***	**5.6274*** **
Delivery speed	12.67%	11.17%	10.68%	11.51%	**0.97464**	**1.0937**	**0.40841**
Delivery pickup point conv.	18.45%	5.46%	6.09%	9.34%	*9.8749****	**8.6681*** **	**−0.88628**
Return	46.07%	22.19%	36.11%	31.78%	**9.6433*** **	*2.9536****	**−4.9971*** **
Return shipping cost	12.27%	12.92%	16.18%	13.36%	−0.60009	*−2.3159***	**−1.8034* **
Return processing time	5.68%	3.78%	7.11%	4.97%	**3.6128*** **	**−1.2699**	**−3.1408*** **
Return convenience	28.11%	5.49%	12.82%	13.45%	**12.651*** **	*6.6631****	**−4.9095*** **

Note: The *t*-values in bold indicate that the results are consistent with our original results considering their statistical (in)significance.The *t*-values in italics indicate that although they are not consistent with our original results considering their statistical (in)significance but consistent considering their signs.

The model fit values for one-class model: Log likelihood = − 6841.428 (df = 54), AIC = 13790.86, BIC = 14017.79.

The model fit values for two-class model: Log likelihood = − 5828.493 (df = 109), AIC = 11874.99, BIC = 12333.06.

The model fit values for three-class model: Log likelihood = −5121.327 (df = 164), AIC = 10570.65, BIC = 11259.87.

***$p < .01$; **$p < .05$; *$p < .10$.