Retailer's Dual Role in Digital Marketplaces: Towards Architectural Patterns for Retail Information Systems

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Abstract: Multi-sided markets (MSMs) have entered the retail sector as digital marketplaces and have proven to be a successful business model compared to traditional retailing. Established retailers are increasingly establishing MSMs and also participate in MSMs of pure online companies. Retailers transforming to digital marketplaces orchestrate formerly independent markets and enable retail transactions between participants while simultaneously selling articles from an own assortment to customers on the MSM. The retailer's dual role must be supported by the retail information systems. However, this support is not explicitly represented in existing reference architectures (RAs) for retail information systems. Thus, we propose to develop a RA for retail information systems facilitating the orchestration of supply- and demand-side participants, selling own articles, and providing innovation platform services. We apply a design science research approach and present seven architectural requirements that a RA for MSM business models needs to fulfill (dual role, additional participants, affiliation, matchmaking, variety of services, innovation services, and aggregated assortment) from the rigor cycle. From a first design iteration we propose three exemplary, conceptual architectural patterns as a solution for three of these requirements (matchmaking for participants, innovation platform services, and aggregated assortment).

1 INTRODUCTION

Catalyzed by the implications of the Covid-19 pandemic, the electronic commerce (ecommerce) revenue is expected to increase worldwide and across sectors by more than 20 percent compared to 2019 (Rotar, 2020). In Europe it already accounts for 374 billion euros in total. As customers are only willing to shop at brick-and-mortal (BaM) retailers if they feel safe, they increasingly tend to shop groceries, apparel, jewelry etc. online and aim for digital end-to-end customer journeys (Bhatti et al., 2020; McKinsey, 2020; Dietz et al., 2020). Additional governmental decrees to close BaM shops force retailers to (hazardly) establish additional online sales channels and transform their value proposition for digital platforms (Nicola et al., 2020; Dietz et al., 2020). Indeed, the pandemic drives the digital transformation in retail and wholesale that previously neglected necessary digitalization endeavors (Schütte and Vetter, 2016).

Besides the possibility of establishing electronic shops (eshops), retailers and wholesalers may also participate in existing or build up own digital marketplaces that establish digital multi-sided markets (MSMs) (Van Alstyne et al., 2016; Hagberg et al., 2016; Staykova and Damsgaard, 2015). While eshops act as resellers in a single market, digital marketplaces connect previously independent markets, match individual participants from the MSMs, and enable (retail) transaction between them (Hagiu and Wright, 2015). Digital marketplaces orchestrate multiple markets and thus simplify the interaction with suppliers, logistic service providers, market researchers and other actors (Hänninen, 2018). They focus on the monetization of the matchmaking instead of selling articles with higher margins (Evans and Gawer, 2016; Ivarsson and Svahn, 2020; Choudary, 2015). The orchestration causes (merely indirect) network effects for market participants (Shapiro and Varian, 1998) and marketplace owners implement asymmetric pricing mechanisms for monetizing the matchmaking (Armstrong, 2006; Rochet and Tirole, 2003).

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Although traditional retail companies act as market intermediaries who offer manufacturers' products to customers (reseller mode), the development of digital marketplaces for the implementation of MSMs (as generalization of tow-sided markets) has not been driven by retail, but usually by technology companies. There are several examples of the tremendous success of digital marketplaces such as Amazon, Alibaba and eBay which orchestrate MSMs (Schütte, 2018). It seems unusual that although retailers are a significant factor in any economy and have traditionally linked markets (e.g. producer and consumer markets) for a long time (Levy et al., 2019), the expansion via MSMs was not driven by retailers. So far only a few large retail companies have established their own MSMs (e.g. Walmart, REWE). As digital marketplaces often form the preferred touchpoint for many customers and marketplace owners encapsulate manufacturers from customers, retailers need to establish their own MSMs (McKinsey, 2020; Rotar, 2020). If the owner of a digital marketplace behaves neutral (Kawa and Wałęsiak, 2019; Wang and Archer, 2007), he does not gain ownership of the traded articles (in contrast to e-shops) at any point of the transaction (Hagiu, 2007). It facilitates retail transactions between ecosystems participants by providing interfaces for the interaction (Williamson, 1985). In contrast, competitive marketplace owners possess a dual role and also offer own articles on the digital marketplace (Kawa and Wałęsiak, 2019; Täuscher and Laudien, 2018). They may compete with other supply-side participants offering similar articles. This dual role as marketplace owner and competitor selling own articles in the MSM causes additional requirements for RIS to support them (Wulfert et al., 2021). Although the importance of MSM business models seems to grow, existing literature only focuses on the adaption of business models and respective tools to model them (Evans and Gawer, 2016; Reillier and Reillier, 2017). Consequences of the retailer's dual role for underlying RIS – the digital infrastructure for ecommerce – supporting the specifics of ecommerce and intermediary business model of MSMs are rarely considered (Aulkemeier et al., 2016; Wulfert et al., 2021). A reference architecture (RA) may help to decrease setup time for the digital infrastructure supporting MSMs and standardize processes and interfaces (Angelov et al., 2012). This standardization may ease the participation in the MSM (Eaton et al., 2015) and increase network effects (Shapiro and Varian, 1998). Although domain-specific RAs for the retail sector such as the retail-H (Becker and Schütte, 2004) or ARTS-model (APQC, 2019; OMG, 2019) do exist, literature dealing with domain-specific RAs for ecommerce in general (Aulkemeier et al., 2016) and retailer's dual role on digital marketplaces in particular is sparse according to our thorough research. Thus, we will address this research gap by deriving architectural requirements (AR) for RIS caused by the transformation of a retailer in reseller mode to a marketplace owner and present focal architectural patterns coping with these ARs. For the analysis of ARs for MSMs and development of architectural patterns, the focus will be on the combination of three aspects: the orchestration of formerly independent markets in the sense of MSMs (Armstrong, 2006; Caillaud and Jullien, 2003; Haucap and Heimeshoff, 2018; Rochet and Tirole, 2003), competitive marketplace owners selling own articles(Kawa and Wałęsiak, 2019; Hagiu, 2007), and the establishment of digital platforms from a technical software perspective (Gawer and Henderson, 2007; Tiwana et al., 2010). The architectural patterns will include aspects of technology platforms centering the marketplace owner's RIS as central technological artifact upon which further modules can be developed (Gawer and Henderson, 2007; West, 2003). For deriving ARs we follow a design science research (DSR) approach (Peffers et al., 2007) with the architectural patterns as artifacts (March and Smith, 1995). We use ArchiMate (Open Group, 2019) as language for modeling enterprise architectures to formally present the architectural patterns in a "unified, unambiguous, and widely understood domain terminology" (Nakagawa et al., 2011). For the presentation of the architectural patterns, we will focus on business and application layer.

This research paper is structured as follows: firstly, we introduce related literature concerning architectural patterns in information systems (IS) architecture and MSMs in ecommerce presenting seven ARs. Secondly, we sketch our research approach for deriving architectural patterns. Thirdly, we present three exemplary architectural patterns and elicit on additional architectural considerations for digital marketplaces. Finally, we discuss our architectural patterns and summarize our results.

2 RELATED LITERATURE

2.1 IS Architecture and Patterns

Retail information systems (RIS) include all application systems that are used to support operational tasks in retail. RIS support the execution of the main trading functions and related tasks bridging the discrepancies in the streams between manufacturers and customers in real goods (goods, ser-

vices; returns), nominal goods (money, credits) and information across space, time, quantity and quality (Levy et al., 2019; Barth et al., 2015). Indeed, RIS support the operational-dispositive, the business administration-administrative, the controlling, and corporate planning tasks (Becker and Schütte, 2004). Besides the merchandise management (merchandise planning, logistics and settlement processes), RIS also support business intelligence and necessary corporate-administrative tasks in an integrative manner (Schütte, 2017). Facilitated by the ongoing digitalization of the retail sector, the bridging functions increasingly cope with digital product and price information and adaptations in payment, logistics and distribution processes (Becker and Schütte, 2004; Schütte and Vetter, 2016). In ecommerce trading transaction are carried out digitally to some degree (Laudon and Traver, 2019). Thus, they build digital infrastructures for executing the trading function in online and offline environments.

An IS architecture "is a set of high-level models which complements the business plan in IT-related matters and serves as a tool for IS planning and a blueprint for IS plan implementation" (Willcocks et al., 1997). IS Architectures comprise a high-level sketch of the system and application architecture of a specific company and part of its application architecture (Heinrich and Stelzer, 2009). While concrete IS architectures are dealing with one particular company, RAs abstract from the company's peculiarities, therefore enabling the reuse of architecture components, providing an agreed upon set of concepts and architectural patterns and communicating fixed viewpoints (Giachetti, 2010). The development of a RA is often inspired by concrete architectures or other artifacts and thus has a "descriptive nature" (Galster and Avgeriou, 2011). However, developing a RA based solely on existing research in a prescriptive manner allows to create "a futuristic view of a class of systems" (Galster and Avgeriou, 2011). Research-based RAs focus on the clarification of innovative patterns and aim to convince domain architects of the architecture qualities. Consequently, concrete systems can be developed according to this research-based architecture (Angelov et al., 2008). RAs are either applied to standardize existing systems to ensure interoperability or to facilitate the design and improve the quality of a concrete architecture with architectural guidelines (Angelov et al., 2009; Angelov et al., 2008). They can be used as a starting point for company-specific models to reduce the effort of creating those through reuse of already established artifacts and constructs (Winter and Fischer, 2006). A domain-specific RA is a reference model on a high level of abstraction that provides a view of the essential areas of a domain (e.g. AUTOSAR) without having to consist of complete process and data models (Nakagawa et al., 2011; Galster and Avgeriou, 2011). A RA is the mapping of a process and data models functionality onto system modules (Galster, 2015). Domain-specific IS reference architectures for the retail sector offer a high-level view on architecture components and business functions.

A RA consists of several architectural patterns (Cloutier et al., 2010; Shaw and Garlan, 1996). These patterns are defined as "named collection of architectural design decisions that are applicable to a recurring design problem" (Taylor et al., 2010). These patterns are reusable solutions to common architectural problems within a given domain (Shaw and Garlan, 1996). Additionally, architectural patterns are often parameterized so that they can be applied to specific problems in different organizational contexts (Taylor et al., 2010). The relation between reference model and architectural patterns as building block of the RA and its manifestation in a concrete architecture for a company are illustrated in figure 1.

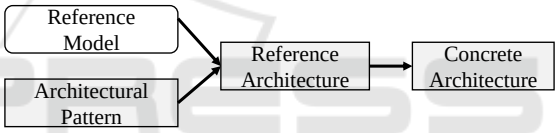

Figure 1: Relation between Architecture Types (Bass et al., 2003).

2.2 Digital Marketplaces

Introducing digital multi-sided markets (MSMs) in ecommerce, we draw on the concept of two-sided markets (Armstrong, 2006; Hagiu and Wright, 2015). Digital marketplaces match two or more previously distinct markets and exploit direct and indirect network effects to further propel the MSM (e.g. one side of the market subsidizing the other (Armstrong and Wright, 2007; Rochet and Tirole, 2003)). While MSMs predominantly operated in the B2C- and C2C-modes, they are starting to be used for B2B transactions more frequently (Li and Penard, 2014). Although the concept of MSMs is also present in BaM retail with shopping malls or variants of trading such as agency trade (Abhishek et al., 2016) and commission business (Müller-Hagedorn et al., 2012), network effects for participants (lower transaction costs for search and initiation) and economies of scale for market owners (marginal costs for adding another supplier or article are almost zero) are even stronger in ecommerce.

AR1: Retailer's Dual Role. Besides taking a neutral role by merely facilitating the matchmaking, the marketplace owner can also behave competitively to supply-side participants offering its own articles to demand-side participants (Wulfert et al., 2021). Hänninen et al. distinguish pure multi-sided digital platform business models that merely facilitate the matching between supply- and demand-side (e.g. eBay, Alibaba, Rakuten) and MSM business models that extend their own range of articles with independent suppliers and offer further services to them (e.g. Amazon) (Li et al., 2019; Hänninen, 2018). The focus of this research paper is on the retailer's dual role as simultaneous marketplace owner and reseller competitive to other supply-side participants (Figure 2). Additionally, marketplaces can be established on the

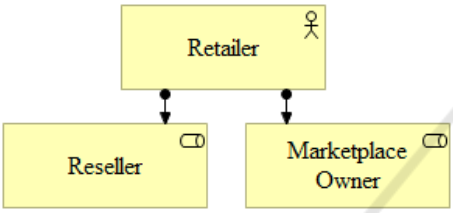

Figure 2: Retailer's Dual Role.

basis of existing BaM stores or eshops as additional sales or procurement channel (Kawa and Wałęsiak, 2019). The marketplace owner can be either one (e.g. Walmart Marketplace) or a conglomerate of the participants (e.g. Opodo) or even an independent third-party (e.g. eBay) (Wang and Archer, 2007). *Requirement:* The RA needs to support both, the orchestration of the market sides (Reillier and Reillier, 2017) and traditional bridging functions with related tasks (Levy et al., 2019; Müller-Hagedorn et al., 2012).

AR2: Additional Types of Participants. For the development of architectural patterns, we focus on the two most important market sides, suppliers (manufacturers, wholesalers, and retailers) and customers (end- customers and retailers). In general, we describe a two-sided market as a specific manifestation of a MSM in ecommerce (Hagiu and Wright, 2015). Moreover, we also integrate third-party developers and infrastructure providers to support the innovation platform perspective (Tiwana et al., 2010; Gawer and Henderson, 2007). Possible additional markets sides are, among others, advertising partners, logistics service providers or opinion research agencies. MSMs differ from the traditional value chain of (offline) retailers and eshops insofar, as that MSMs match manufacturers on the supply-side with end customers on the demand-side. Retailers and wholesalers may interact with a digital marketplace as a supplier or may demand articles from the MSM that is controlled by the marketplace owner (Figure 3). The digital marketplace is modeled as location on which the matching and (parts of) the transaction are executed (Turban et al., 2017; Grieger, 2003). *Requirement:* The different participants within a MSM need to be represented adequately in terms of master data and records need to ensure that transactions between them can be tracked to optimize future matchmaking.

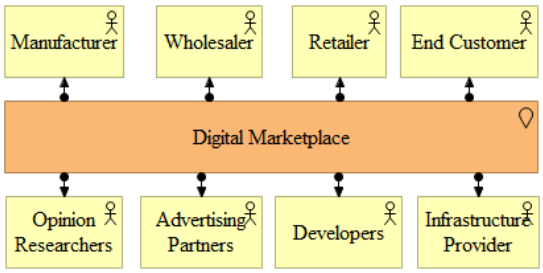

Figure 3: Participants of a Digital Marketplace.

AR3: Affiliation to the Marketplace. In the offline environment retailers try to establish relations with their customers offering e.g. optional loyalty cards or apps (Hanke et al., 2018; Rudolph et al., 2015) Hagiu and Wright argue that the participants of a MSM always require some affiliation with it. However, the way in which the MSM participants must affiliate is not further defined and can be interpreted differently (e.g. contract, membership, cookies) (Hagiu and Wright, 2015). The affiliation is important to improve the likelihood and quality of the matching as it requires information about the participants (Evans and Schmalensee, 2016; Reillier and Reillier, 2017). *Requirement:* The affiliations of the different participants and multiple market sides need to be represented and linked to participant profiles to support and improve the matchmaking.

AR4: Matching as Core Value Proposition. As already mentioned, the orchestration of formerly independent market sides is the core value proposition of a digital marketplace (Armstrong, 2006; Evans and Schmalensee, 2016; Rochet and Tirole, 2003; Rochet and Tirole, 2006). This involves the matching of single participants of the MSMs (Moazed and Johnson, 2016). The matching can be described according to Reillier and Reillier as a process of attracting, matching, and connecting participants to enable (retail) transaction between them. The transaction process and matching are optimized afterwards (Reillier and Reillier, 2017). The matching between supply- and demand-side participants can be illus-

trated in a schematic two-sided sales funnel (Figure 4) as an extension of the ecommerce sales funnel (Blank and Dorf, 2012). In the attract phase, both supply- and demand-side participants are acquired and activated while already existing participants are tried to retain. For matching both sides, the participants need to be introduced to each other considering their characteristics captured within the participants affiliation with the MSM. The assortment of supply-side participants has to match the purchase desire of demand-side participants and the digital marketplace should provide appropriate matching partners (Evans and Schmalensee, 2016). Next both participants need to be connected to execute a retail transaction that can be coordinated by the marketplace owner. Finally, the transaction is optimized in order to transact further articles within this matched pair or derive insights for further transactions between other participants (Reillier and Reillier, 2017; Blank and Dorf, 2012). *Requirement:* The matching process needs to be supported by both, business and application services.

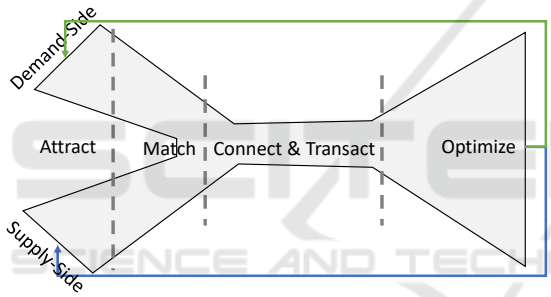

Figure 4: Matching Market Sides in Ecommerce.

AR 5: Diversity of Services. Digital marketplaces differ with regards to the type, scope, and coverage of services offered by the marketplace owner (Wulfert et al., 2021). When adding additional services, marketplace owners enhance their core value proposition. The degree of additional services offered by a digital marketplace varies on a continuum between the passive matching (e.g. eBay classifieds) to full service offerings with sales processing, fulfillment services and training services (e.g. Amazon) (Wang and Archer, 2007; Wulfert et al., 2021). With regards to the main bridging function (Levy et al., 2019), a substantial amount of them may be performed by other MSM participants or the marketplace owner depending on the degree of centralization of the MSM (Hein et al., 2016; Wang and Archer, 2007). As MSM typically mature by offering additional services (e.g. Amazon, eBay) (Reillier and Reillier, 2017), RIS should be flexible to support the integration of further services carried out by the MSM. A modular design will also support the service continuum of MSM from pure-matchmaking to innovative marketplaces. *Requirement:* The RA should be defined in a flexible and modular way, so it supports the development and integration of services that are not yet part of the business model but are likely to be integrated in the further evolution of the MSM.

AR6: Innovation Platform Services. Besides trading-related services, digital marketplaces can also offer innovation platform services for the marketplace participants like access to sales data or smart product-related data or remote services not associated with the core trading business (Tiwana et al., 2010). These services can also be compute power, storage, or development environments like Amazon provides with its Web Services that originated from the variability of demand on computing resources in the ecommerce business (Wittig et al., 2016). Innovation services are the technical capabilities that enable the creation of new solutions (services or software modules) by participating third-party developers (Asadullah et al., 2018). Integrating both transaction and innovation services, the digital marketplace resembles an integrated platform (Evans and Schmalensee, 2016) The power of innovation platforms rests on their architectural modularity (Baldwin and Clark, 2000; Tiwana et al., 2010), catalyzing re-configurability of technical and organizational components to accelerate generativity and value creation. The components of single modules are strongly interconnected but weakly connected with the central platform through technical boundary resources (Baldwin and Clark, 2000; Tiwana, 2015). To enable the development of external modules or apps by external developers and make use of the development environment provided by the innovation platform, platform providers open their platform and implement technical (e.g. APIs and SDKs) and provide social (e.g. documentation and technical support) boundary resources. External modules make use of technical boundary resources provided by the innovation platform (Eaton et al., 2015; Ghazawneh and Henfridsson, 2013). *Requirement:* The RA needs to include these innovation platform services and respective boundary resources to enable developers to exploit the offered services.

AR7: Digitally Aggregated Assortment. Digital marketplaces aggregate a digital representation of the diverse assortment of articles offered by supply-side participants. The assortment can be described as the periphery of the MSM while the core is the MSM itself offering services to supply- and demand-side participants as described analogously in the platform lit-

erature (Baldwin and Woodard, 2009; Staykova and Damsgaard, 2015). From a customer point-of-view MSMs "resemble retail agglomerations" (Hänninen, 2018) integrating the range of articles of participating suppliers, retailers and wholesalers through a single digital channel (Teller and Elms, 2010). Thus, digital marketplaces further reduce transaction costs (Williamson, 1985) for participants as a variety of articles can be sold or purchased via a single touchpoint with a consistent user experience. Digital marketplaces also reduce the number of intermediaries to participate in a single customer journey and uniform boundary resources (Eaton et al., 2015; Ghazawneh and Henfridsson, 2013). Ecommerce in general and the aggregation of the individual assortments of various supply-side participants require a digital representation of the articles within the assortment (Turban et al., 2017). *Requirement:* The RA should include a flexible model of the article master data to allow the aggregation of the assortments.

3 RESEARCH APPROACH

For developing architectural patterns for RIS supporting the orchestration of MSMs, different types of participants in ecommerce, and innovation platform services, we apply a DSR approach as presented in figure 5 (Peffers et al., 2007). The problem-initiated process starts with the problem (1) already stated in the introduction. The objectives of the artifact (2) to be developed are the ARs as derived in section 2.2. Exemplary architectural patterns as a solution (3) to the problem will be presented in the next section. An evaluation based on informed arguments (Hevner et al., 2004) is contained in the discussion section.

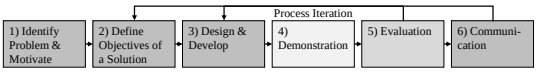

Figure 5: DSR Approach (Peffers et al., 2007).

The outcome of the DSR approach is a model (March and Smith, 1995) or more particular (parts of) an architecture (Vaishnavi et al., 2019). Developed as "meta-artifacts" (Iivari, 2003), the architectural patterns represent a "general solution concept" (Van Aken, 2004) that is applicable to a class of problems when instantiated in the context of electronic retail (March and Smith, 1995). The architectural patterns (artifacts) are a new solution for an already known problem and thus resemble an improvement (Gregor and Hevner, 2013). These patterns can describe major tasks of a digital marketplace and present them in a formal and understandable manner applying a highly regarded enterprise architecture modeling language (i.e. ArchiMate). A DSR should go through three cycles (Hevner and Chatterjee, 2010). While the focus of our overarching research is developing and evaluating a RA supporting digital marketplaces in ecommerce with transaction and innovation functions (Evans and Gawer, 2016), this design cycle presents exemplary architectural patterns pivotal to MSM business models in ecommerce. Our research approach can be summarized as follows: Firstly, we derive ARs based on a prior literature analysis as presented in section 2.2 (rigor cycle). Secondly, we develop conceptual architectural patterns as general solution concepts for these requirements (Iivari, 2015). Hence, we develop domain-specific architectural patterns as building blocks of an overarching RA based on literature (Galster and Avgeriou, 2011; Angelov et al., 2008). This design cycle focuses on deriving architectural patterns from the rigor cycle and modeling them in ArchiMate. The literature-based architectural patterns can then also be used as additional artifact when analyzing existing RAs for retail in general and ecommerce in particular. For a future relevance cycle, we will conduct interviews with IT architects and responsible IT staff architecting (parts of) an organization's (IS) architecture. The retailer's dual role and additional innovation services (Gawer and Henderson, 2007; Tiwana et al., 2010) cause additional requirements for RIS that need to be reflected in RAs for ecommerce. Thus, we present three exemplary architectural patterns for these additional requirements (AR5-7) not met by existing domain-specific RAs.

4 ARCHITECTURAL PATTERNS

4.1 Pattern 1: Matching of Participants

The first exemplary architectural pattern addressing AR5 is concerned with the matchmaking between participants from different market sides as core value proposition of a digital marketplace (Armstrong, 2006; Choudary, 2015). The matching sequence as illustrated in figure 6 is executed by the retailer or wholesaler in its role as marketplace owner. The matching process is embedded in the matching sequence as proposed by Reillier and Reillier (2017) and introduced in section 2.2. After the attraction of supply- and demand-side participants, participants from independent markets need to be matched. In the context a customer's desire usually leads to a product search either via search query or category search (Kotler and Keller, 2016). Based on the customer's preferences stored in the customer data, the matching

engine situated in the customer and supplier relationship management systems calculate the order of the listed assortment. Thus, the relevance with regards to the search term is not the only factor when listing articles as a result of the customer's query, the preferred supplier may also be considered. Matching participants from supply and demand side of the MSM requires an interface between these independent systems to exchange supplier and customer data relevant for the matching. The listing of the assortment is an important internal driver for retailers to increase revenues in ecommerce (Chen et al., 2014). On digital marketplaces the product listing is even further complicated by the retailer's dual role causing the question whether to prefer products from the own assortment or from another ecosystem participant's assortment. A higher priority for the owner's assortment cannot be implemented because of antitrust law considerations (Bundeskartellamt, 2015). The matching can be initiated proactively to stimulate a customer's desire (e.g. customized newsletters, social media marketing, search engine advertising). After a match has been created successfully, the retail transaction can be executed. To optimize the matching sequence, supplier and customer data are enriched with information derived from the executed past transaction and other demand-side participants from the same cluster may get notified of the previous transaction.

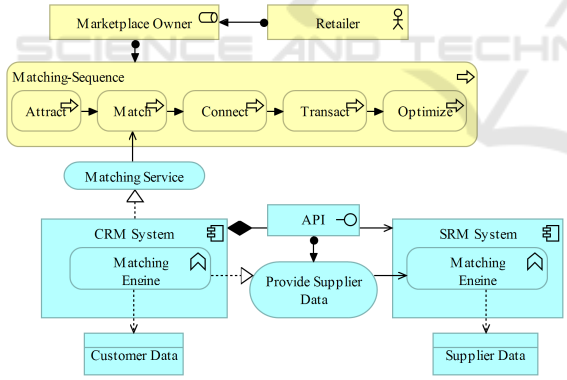

Figure 6: Matching as Core Value Proposition.

4.2 Pattern 2: Innovation Services

The second exemplary pattern addresses AR6. This conceptual pattern emphasizes the integration of innovation platform services (Figure 7) in a digital marketplace (Tiwana et al., 2010; Evans and Gawer, 2016). Offering innovation services (Tiwana, 2015) focusing on the development of additional modules or apps requires to open the RIS and supporting infrastructure for third-party developers by implementing application (e.g. APIs and SDKs) and provide social (e.g. documentation and technical support) boundary resources (Ghazawneh and Henfridsson, 2013; Eaton et al., 2015). External modules are developed using technical boundary resources provided by the innovation platform in the form of API services (Ghazawneh and Henfridsson, 2013; Eaton et al., 2015).

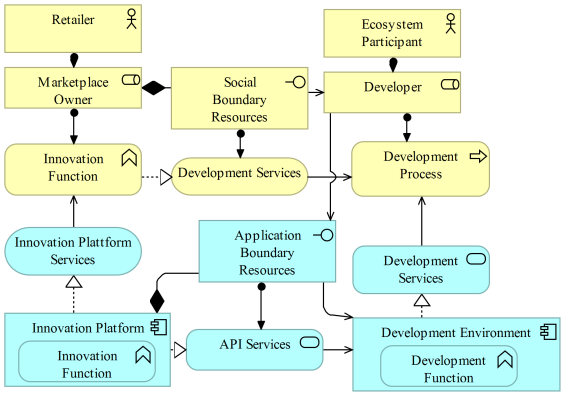

Figure 7: Innovation Platform.

The openness of an innovation platform defines which platform services and components from the application and infrastructure layer can be used, modified, and extended by third-party developers (Witte and Zarnekow, 2018). Openness is usually defined by the scope and richness of the interfaces offered by the platform owner (Eisenmann, 2008). The development environment can also be operated by the marketplace owner depending on the degree of openness and the boundary resources provided. Third-party developers implement additional modules such as shop themes, interfaces to other digital platforms, or feature add-ins. While innovation platforms usually exploit economies of scale and scope with increasing efficiency and increased product variety trough reusability and reconfiguration of modules or services, they may utilize further economic effects as the center of a broader innovation ecosystem in which they may also establish MSMs (Cusumano and Gawer, 2002; Gawer, 2009; Buxmann and Hess, 2015). The development process consists of, among others, processes for developing, testing, and deploying the modules. The integration of innovation services propels the development to a hyper-scaling platform (Dawson et al., 2016) Retailers increasingly establish innovation platforms and provide them to other competitors to create an integrated digital business ecosystem. One example is REWE with its subsidiaries commercetools and fulfillmenttools (commercetools, 2020).

4.3 Pattern 3: Aggregated Assortment

A conceptual solution for AR7 is presented in the third exemplary architectural pattern (Figure 8). This conceptual pattern deals with the aggregation of the individual assortments of the different supply-side participants (Teller and Elms, 2010).

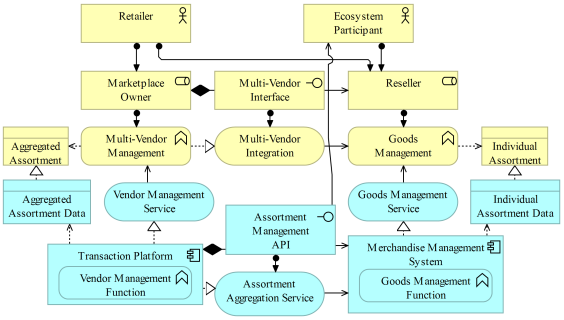

Figure 8: Aggregated Assortment of a Digital Marketplace.

The aggregation of the assortment is managed by the retailer in his role as marketplace owner. The marketplace owner aggregates the assortment of all supply-side participants in reseller mode. This may also include the retailer himself (i.e. dual role) (Hagiu, 2007). While a multi-vendor integration connects the supply-side participants on the business layer to the marketplace, the technical integration between the transaction platform and the merchandise management system of the reseller is realized by the assortment aggregation service on the application layer. This service provides an assortment management API connecting the systems of the marketplace owner and the supply-side participants (Ghazawneh and Henfridsson, 2013). For a retailer with a dual role this means the listing of its own assortment on the marketplace. The assortment of each reseller is stored in an individual assortment business object accounting for possible further sales channels of the reseller. The aggregated assortment is also captured by the marketplace owner in a business object realized by a data object. The data objects are managed by the transaction platform (for the marketplace owner) and the merchandise management system (for the reseller)

5 DISCUSSION

Within this research paper we present three exemplary architectural patterns pivotal for the retailer's dual role on digital marketplaces. They are developed based on seven ARs derived from the literature on ecommerce in general and MSMs in particular. Although there could be more than one MSM for a specific ecommerce sector (Senyo et al., 2019), winner-takes-all-tendencies and strong network effects of incumbents limit it to only one or a few (Eisenmann, 2008; McIntyre and Srinivasan, 2017). A RA or multiple architectural patterns supporting a retailer's dual role on digital marketplaces simplify the assessment of RIS prior to the transition to a MSM. Hence, the capabilities of the IS for the marketplace transformation can be assessed more accurately and may lower the possibility for failures during the establishment of digital marketplace. Several digital marketplaces failed to establish successful MSMs (e.g. zapatos, jet.com, Rakuten) either because of a small number of participants or IS problems (Wulfert et al., 2021). The domain-specific RA can also be used to identify potential gaps within the retailer's RIS and reduce the overall time to market (Angelov et al., 2012). A retailer's or wholesaler's dual role on a digital marketplace results in several advantages compared to other ecosystem participants (Figure 3). Despite possible antitrust law considerations (Bundeskartellamt, 2015), the marketplace owner will be eager to prefer the offering of its own assortment to increase reseller revenues. As the marketplace owner controls the touchpoint to the customer, he also has the information about fast selling and profitable articles. This information can be used to adjust the assortment of the reseller role mainly selling profitable articles and leaving the long tail (McAfee and Brynjolfsson, 2017) of articles selling slowly to other ecosystem participants. The concentration on fast selling articles may also release storage capacity that can be offered as additional, retail-related services to ecosystem participants (Wulfert et al., 2021). Also With additional sales information, the marketplace owner can calculate articles for which the monetization of the matchmaking (e.g. commission fees) is more profitable than selling these articles in its reseller role. The matching as core value proposition of a digital marketplace (Armstrong, 2006; Haucap and Wenzel, 2011) relies on proper data concerning customers, suppliers, and articles. Thus, the data needs to be stored accessibly for the matching engines to provide the customers with desired products. The actual article is the customer's focus in the ecommerce environment (Hagberg et al., 2016) while suppliers are encapsulated by the marketplace owners (McKinsey, 2020). Nevertheless, we propose to include supplier information in the matchmaking process as customer preferences can be matched on suppliers' properties. Customers caring about their environment may for example be likely to buy articles from a supplier who can prove sustainability. Integrating additional innovation services attracts additional participants to the MSM and adds

additional value propositions. The range and scope of modules developed by third-party developers depend on the openness allowed by the marketplace owner and the provided boundary resources (Ghazawneh and Henfridsson, 2013; Eaton et al., 2015). These modules can be related to the bridging functions enhancing the retail transactions between supply- and demand-side participants (e.g. shop themes, vendor management) or go beyond retail-centered purposes. Amazon is a major example for the wide range of external modules with its Web Services stemming from the usage of unused computational power from the retail activities (Wittig et al., 2016). Hence, the modeled innovation platform and development environment components are generic enough to cope with the whole continuum of external modules. The innovation pattern needs to be instantiated according to the intention of a specific marketplace owner. Digital marketplaces aggregate the assortment of several supply-side participants and require a data model for the articles capable of storing much unstructured data (image, video, exploded-view drawings, spare parts with historical data, etc.). The data model must be designed flexible so that it is suitable for different product categories agglomerating the diverse assortments of a number of participants from independent markets (Kollmann, 2019; Evans, 2011). This may lead to a decoupling of the master data storage of a transaction processing system (e.g. enterprise resource planning) from the transaction platform and the system for product information management. This is mainly because not all articles or services of a MSM can be kept in a transaction platform with all available data. While the transaction platform requires high resolution images for digital representation in the ecommerce environment, the enterprise resource planning systems is mainly concerned with financial and inventory data. However, the degree to which article data is stored in the transaction platform and provided by an additional product information system depends on the specific environment of the retailer. The product information system is not modeled in pattern 3 for reasons of graphical simplification. These architectural patterns from the first design iteration should be further evaluated with practitioner insights and aggregated to an overal RA for RIS supporting a retailer's dual role on digital marketplaces. Aggregating transaction and innovation services, the digital marketplace forms an integrated platform (Evans and Schmalensee, 2016). The transaction platform is included in pattern 3 while the innovation platform is part of pattern 2. An integrated platform is likely to become an hyper-scaling platform quickly achieving critical mass and shaping industries (Dawson et al., 2016) This research paper also has its limitations. The developed ARs are neither comprehensive nor complete. AR must also be derived from practitioner sources (e.g. interviews, architecture documents) in an additional relevance cycle for a more sophisticated analysis. We plan to derive further ARs and evaluate the seven ARs as well as the three architectural patterns developed conducting interviews with IT architects from retailers operating MSMs. Although we claimed that the ARs are derived from our literature analysis and make up the sole base for the developed architectural patterns, we need to acknowledge that the ARs are biased from our own understanding of the meta-problem. We incorporated our understanding of the retail-specific problem and retailer's dual role on digital marketplaces that leads to interpretations with regards to the AR and architectural patterns (Iivari, 2015). Moreover, the chosen enterprise architecture modeling language for developing the architectural patterns leads to an implicit decision for a service-oriented architecture design as this is inherent to this language connecting actors as well as business, application and infrastructure layers using services (Open Group, 2019). Although service-orientation is a well-regarded paradigm, it can at least be questioned if it is the best approach for modeling the IS architecture of a digital marketplace with the focus on the retailer's dual role.

6 CONCLUSION

The main contribution of this research paper is the determination of a retailer's possible dual role on digital marketplaces. We derive seven ARs resulting from a retailer's dual role (dual role, additional participants, affiliation, matchmaking, variety of services, innovation services, and aggregated assortment) for RIS. These requirements resemble a class of problems relevant for digital marketplaces in ecommerce. Additionally, we propose three architectural patterns (matchmaking for participants, innovation platform services, and aggregated assortment) as a conceptional solution to the requirements. These architectural patterns are developed literature-based and can be applied to analyze existing RA towards the fulfillment of these requirements. The patterns resemble buildings blocks of a meta-model as a RA for the retail domain. Future research can test existing (scientific and practice) concrete architectures and RAs for the fulfillment of the requirements and patterns. The architectural patterns may also be improved by consolidating domain knowledge such as company-specific architectures and conducting interviews with IS architects. Another important avenue for future

research may be an extension of the range of architectural patterns and orchestrating them to a complete RA including further architecture layers. For the demonstration and evaluation of presented and additional patterns, they can be implemented in a concrete or experimental system as proof of concept.

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