Developing and leveraging platforms in a traditional industry : an orchestration and co-creation perspective

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Developing and leveraging platforms in a traditional industry:

An orchestration and co-creation perspective

Abstract

In the current fast-changing and digitalizing world, ever more firms active in traditional industries are transforming themselves into 'Smart Factories'. Within their value chains, manufacturers are shifting from working at arm's length with other firms, to creating integrated platforms. These are composed of co-creating and collaborating actors. Even though the opportunities and competitive advantages of platforms for industrial applications have been proven, insights in the lead actors' efforts to ensure co-evolution of the platform and the platform actors' contributions to value co-creation are scarce. That way, the full potential of collaborative firm settings might not be realized. Addressing this gap, we explore through a multiple case study how manufacturers in the traditional Chinese textile industry gradually adopt a platform-based logic. This results in an integrative framework unfolding the lead actor's orchestration capabilities to ensure co-evolution, and the prerequisites for value co-creation in a platform. As such, we adapt and extend the co-evolution concept mostly examined in a dyadic setting to a multiple actors' logic and answer calls for additional research on the micro-foundations of value co-creation in platforms.

Key words: Platform; Value co-creation; Co-evolution; Orchestration capability

1 Introduction

In today's digital, interconnected and networked environment (Forkmann, Henneberg, & Mitrega, 2018), the competitive advantage of firms stems from managing relationships and resources. Technology platforms are considered increasingly significant, among types of collaboration intended to co-create value (Möller & Halinen, 2017). Firms able to leverage platforms grow dramatically in size and scale (Evans & Gawer, 2016). With their platform logic, firms such as Alibaba, Amazon, and Apple have become some of the world's most valued firms (Zhu & Iansiti, 2019). The proven advantages of platforms, such as an increased ease of activity monitoring and communication (Zhu & Iansiti, 2019), stimulate many traditional firms to reflect upon how to adopt a platform thinking logic to redefine the dynamics of competition within and across sectors while sustaining their competitive advantages (Constantinides, Henfridsson, & Parker, 2018).

Manufacturers are constantly confronted with a fast-changing and more digitalized world (Eloranta & Turunen, 2016; Kohtamäki & Rajala, 2016). As a result, they adopt the 'Smart Factory' which constitutes a key feature of Industry 4.0 (Strozzi, Colicchia, Creazza, & Noè, 2017) and is characterized as 'the integration of all recent IoT technological advances in computer networks, data integration, and analytics to bring transparency to all manufacturing factories' (Lee, 2015, p. 230). Manufacturers adopting this approach intensify their value chain relations with other firms in order to become co-creating partners in integrated platforms. This allows them to flexibly re-configure assembly lines (Lu, 2017; Radziwon, Bilberg, Bogers, & Madsen, 2014), rapidly respond to shifting customer demands (Li, 2016), and allow for customized offerings in a resource-saving and cost-effective way (Gaub, 2016).

Even though the possibilities and competitive advantages of platforms for industrial applications have been proven (Chi, Wang, Lu, & George, 2018; de Oliveira & Cortimiglia, 2017; Matthyssens, 2019), insights in the manufacturer's role as the lead actor and necessary capabilities to ensure co-evolution of the platform and its actors' underlying contributions to value co-creation, are scarce. As collaboration and co-creation of value in a B2B context (Jaakkola & Hakanen, 2013; Kohtamäki & Rajala, 2016; Marcos-Cuevas, Nätti, Palo, & Baumann, 2016) have been proven to enhance firms' reputation and innovation outcomes (de Oliveira & Cortimiglia, 2017) and trust among co-creating actors (Frow, McColl-Kennedy, & Payne, 2016; Hewett & Bearden, 2001), additional insight into the foundations of this process in the frame of platforms would be beneficial.

We therefore address the following research question: *'What are the underlying building components to ensure co-evolution of and co-creation within a platform, and how do these allow for platform development and leverage?'*. To answer this question, we adopt a systematic combining approach (Dubois & Gadde, 2002) and identify the lead actor's – that is, the manufacturer's – necessary orchestration capabilities to ensure co-evolution among key platform actors (Eloranta & Turunen, 2016; Perks, Kowalkowski, Witell, & Gustafsson, 2017; Thomas, Autio, & Gann, 2014). On top of this, we examine the actors' contributions to co-creation (Kohtamäki & Rajala, 2016). All in all, we argue that a joint effort in co-evolution and co-creation allows for exploiting the potential of a platform-based logic.

By doing so, we provide two overarching theoretical contributions to the literature on co-evolution and co-creation in platforms. First, we adapt and extend the co-evolution concept mostly examined in a dyadic setting (e.g., Matthyssens, Vandenbempt, & Weyns, 2009; Tiwana, Konsynski, & Bush, 2010) to a multiple actors' logic. More specifically, we fine-tune and develop Helfat and Raubitschek's (2018) integrative capabilities necessary for ecosystem orchestration into three orchestration capabilities suitable for platform-based logics: Targeting, legitimizing & envisioning, and expertise building. Second, we identify the actors' contributions to co-creation in a dynamic, IT enabled context (i.e., a platform) and argue that each platform actor type (i.e., customers, or suppliers / technology partners) acquires different co-creation practices and provides specific contributions to co-creation. Overall, we answer calls for additional research on platforms (e.g., Perks et al., 2017) and, more specifically, on the micro-foundations of value co-creation within a platform (e.g., Storbacka, Brodie, Böhmann, Maglio, & Nenonen, 2016).

The paper is constructed as follows. We start with discussing the theoretical foundations. First, we discuss the concept of platforms. Next, the lead actor's role in platform co-evolution is considered and the concept of orchestration capabilities is introduced to ensure co-evolution between platform actors. Then, we describe a platform's leverage effects. We explicitly recognize the existence of four theoretical platform logics: Production-incremental, production-radical, transaction-incremental, and transaction-radical. For each platform logic, we describe its main characteristics and expected leverage effects. Finally, we investigate the platform actors' contributions to value co-creation and their co-creation practices. The actors' necessary input to further exploit and leverage the potential of a platform-based logic is described.

We use these theoretical insights as a lens to observe manufacturers adopting a Smart Factory perspective and use the empirical findings to integrate and further fine-tune the theoretical thrusts. To do so, we present and analyze four cases of Chinese pioneer textile manufacturers that gradually adopted a platform-based logic. Our choice for China and its textile sector as an empirical setting is twofold. First, China is not only leading in the 'development of the enabling technologies of the Smart Factory, with more than 2500 patent registrations, compared to 1065 registrations in the USA and 441 in Germany' (Strozzi et al., 2017, p. 6579), but has also one of the largest traditionally 'low-tech' textile industries (Kirner, Kinkel, & Jaeger, 2009; Mendonça, 2009; Yang & Zhong, 1998). Second, firms in this industry started to adopt a wide variety of digital technologies in their business processes (Bertola & Teunissen, 2018; Chen & Xing, 2015), allowing them to adopt and exploit platform-based logics. Thus, these textile firms form a perfect setting to examine the underlying building components to develop and leverage the potential of a platform. The conclusion provides implications for theory and practice and suggestions for future research.

2 Theoretical background

The steady increase in studies about *platforms* led to the development of a wide variety of platform categorizations; both from a practical and a theoretical point of view (e.g., De Reuver, Sørensen, & Basole, 2018; Gawer, 2009; Thomas et al., 2014). For example, De Reuver et al. (2018) refer to 'digital' versus 'non-digital' platforms and explain that digital platforms consist of a software-based codebase, i.e., a technical artefact. Various modules extend the functionality of such a software product and jointly lead to a digital platform. The platform provides the technological foundation to allow platform actors to develop innovations and increase the system's value (Teece, 2018). IoT-based platforms foster opportunities for the highest degree of digital innovation, as opposed to low-level pure-technical platforms (De Reuver et al., 2018). Parallel to these digital platforms, exist three types of 'non-digital' platforms: Internal platforms, supply-chain platforms, and industry platforms (Gawer, 2014). Here, the platform acts as a mediator between different user groups, which can be a firm's sub-units (e.g., an internal platform), a focal assembler and its external suppliers (e.g., a supply-chain platform), or complementors (e.g., an industry platform) (Gawer, 2014).

Interestingly, manufacturers can adopt *both* the mediating (i.e., non-digital) platform viewpoint designed to organize collaboration between different users, as well as the digital platform viewpoint focusing on technological innovations. Combining these two platform perspectives can lead to an overall improvement of the manufacturer's business processes, i.e., both regarding collaborations and technological innovations (Jacobides, Cennamo, & Gawer, 2018). Thomas et al. (2014) conceive a platform as 'the organizational structure that stores organizational capabilities' (p.201). In this view, an organization's resources can, due to the technical opportunities the platform offers, be recombined in such a way that the organization is able to rapidly respond to, e.g., changes in customer preferences, unexploited market demands or a digitally enabled competitive landscape. In other words, as a result of the platform, the firm can recombine its resources and develop (internal) dynamic capabilities. For example, Teece (2017) states that in a platform setting, firms can easily sense environmental opportunities, seize new market segments and improve their fit with the business environment. As such, the technical opportunities offered by the platform *enable* increased value creation.

The technical advantages of platforms thus hold promise to create value for *all* users involved by connecting two (or more) types of actors which otherwise would not have been able to connect or transact (Gawer, 2014). Such value, captured by various actors, increases as the number of participants in each actor type grows. This is known as ‘network effects’ (Van Alstyne, Parker, & Choudary, 2016). Network effects are prevalent and typical in platforms, triggering a self-reinforcing cycle of innovation and value growth (Evans & Gawer, 2016). Powerful and superior network effects can bring great advantages in platform competition (Gawer, 2014). Thus, a platform enables increased value creation facilitated by technological advancement. In addition, various (if not all) platform actors take advantage of such increased value creation thanks to close collaboration among the platform actors. Platforms are understood as IoT-enabled environments containing dynamic relations of technologies, interactions, processes and humans, which stimulate value co-creation practices within a network of complementors, eventually leading to competitive advantages for all actors involved (Perks et al., 2017; Ramaswamy & Ozcan, 2018).

In network literature, co-evolution is considered essential to ensure optimal network functioning (Paquin & Howard-Grenville, 2013; Perks et al., 2017). Co-evolution refers to the fact that ‘changes and developments of any actor in a relation or network are to a large extent determined by changes of the other actors’ (Matthyssens et al., 2009, p.510). In the case of intentionally built networks, a network orchestrator (e.g., the lead actor) needs to demonstrate to *all* (potential) network members that being an active part of the network is beneficial (Paquin & Howard-Grenville, 2013). The orchestrator needs to shift its attention from 'initially encouraging serendipitous encounters between network members ('blind dates') to increasingly selecting members and more closely influencing their interactions ('arranging marriages')' (Paquin & Howard-Grenville, 2013, p.1623). The orchestrator thus does not only have a structural brokerage role (Burt, 1992). He also needs to act as a relational broker or gatekeeper (Foster, Borgatti, & Jones, 2011; Obstfeld, 2005). As such, he can enable value creation for the entire network (Dyer & Nobeoka, 2000; Provan & Kenis, 2008). For this, the orchestrator needs to develop orchestration capabilities allowing him to, e.g., establish broad legitimacy between partners in the initial network development stage ensuring that all partners agree on the platform's legitimacy and vision (Paquin & Howard-Grenville, 2013).

Finding platform partners able to provide value (and innovativeness) to the platform as a whole and the legitimation of the value platform through the entire network have been put forward as important platform orchestration capabilities (Perks et al., 2017). Even though some first studies regarding the importance of orchestration capabilities thus portray that they allow the lead actor to manage co-evolution between platform actors, its specificities are still largely unknown, in particular in traditional industries (Eloranta & Turunen, 2016).

2.1 Platform leverage

Platform leverage refers to the logic of engaging network actors to combine and integrate resources in such a way that value co-creation and network effects are enhanced without a corresponding increase in the consumption of resources (Storbacka et al., 2016). According to Thomas et al. (2014), there are three types of architectural leverage logics in platforms: Production, transaction and innovation leverage. Production leverage entails a (re)use and sharing of different 'component designs, manufacturing processes, distribution channels, and suppliers' (p.206). As such, production development time decreases and both economies of scope and scale can be attained. Transaction leverage is based on 'the manipulation of the market pricing mechanism and market access, which drives transaction efficiency and reduces search costs in the exchange of goods and services' (p.207) and implies the existence of economies of transaction and search (Economides & Katsamakas, 2006). Innovation leverage entails the sharing and (re)use of assets, enabled through interfaces and standards. Here, however, the focus is on economies of innovation and complementarity, and not on scope and scale (Thomas et al., 2014). Building upon the radical and incremental nature of technological innovations (Dewar & Dutton, 1986), the idea of platform innovation leverage can be adjusted by distinguishing incremental from radical innovation leverage. Subsequently, it extends Thomas et al.'s (2014) architectural leverage logic into four types by combining two dimensions: Incremental versus radical innovation leverage and transaction versus production/back end leverage. This results in the following four theoretical platform logics: Production-incremental, production-radical, transaction-incremental, and transaction-radical.

The production-incremental logic upgrades a firm's production and logistics activities by sharing and exploiting production resources in the back-end process, implying not only production operations but also supply and logistics related activities and partners. Coreynen, Matthyssens and Van Bockhaven (2017) consider back-end processes as being related to the efficient development and deployment of solutions, such as improving operational production and supply-oriented costs. Cenamor, Rönnberg Sjödin, and Parida (2017) state that the back-end unit might assume a role of platform orchestrator. As such, the production-incremental logic emphasizes the use of platforms in strengthening back-end value additions and improving responsiveness and customization to customer needs. For instance, Radio-Frequency Identification (RFID) enabled logistics and supply chain platforms help to achieve real-time tracking in a warehouse or in a firm's supply chain (Hsu, Chen, & Wang, 2008; Vijayaraman & Osyk, 2006). FIspace is another example, where a supply chain platform supported by advanced ICT components is used to increase B2B collaborations. Thanks to FIspace, supply-side information shared through the platform is transparent, which stimulates further integration of the entire supply chain in the food industry (Barmpounakis et al., 2015; Kruize et al., 2014).

The production-radical logic builds on a networked production foundation to ensure back-end units can re-invent their management approaches. As such, radical value innovations are enabled, allowing for extensive lead time reductions and higher degrees of adaptability towards customers' specific needs. For instance, TRUMPF – a German machine tool manufacturer – founded AXOOM, a smart manufacturing platform for Industry 4.0. The AXOOM platform connects manufacturers, machines, sensors and software, and enables cloud-based data storage and analysis (Gerrikagoitia, Unamuno, Urkia, & Serna, 2019) enabling TRUMPF to offer innovative platform solutions and strategies for customers such as a software to schedule workloads.

The transaction-incremental logic emphasizes the optimization of marketing solutions by utilizing incremental innovation arrangements in the front-end process. Zomerdijk and de Vries (2007) explain that front-end process optimization is related to (p.111) 'reducing the ratio of high-contact to low-contact work' enhancing the speed and quality of customer interactions. Basic IT-enabled functions facilitate service operations, such as collaborations between firms and their distributers (Chi et al., 2018). An example of a transaction-incremental logic is an online B2B auction platform, to create a more efficient and effective procurement process (Baikerikar, Kavthekar, Dsouza, Fernandes, & Dsouza, 2017).

Finally, the transaction-radical logic focuses on accelerating the solution optimization process by utilizing digital innovation arrangements that destroy existing value chains and replace business models. This platform logic facilitates the implementation of advanced service offerings and reconstructs the role of front-end units as solution builders. The MindSphere platform from Siemens widens its offerings with IoT related services in order to deliver Industry 4.0 solutions to manufacturers. MindSphere is a cloud-based IoT operating system that assists manufacturers to connect products, plants, systems and machines, enabling them to gather and analyze the wealth of data generated by IoT with advanced analytics (Collis & Junker, 2017; Novikov & Sazonov, 2019; Siemens, 2020). Through predictive and proactive services (e.g., software to predict when spare parts are needed), additional value is created for both Siemens and its customers (e.g., addressing equipment issues up front and increasing plant performances).

Fig. 1 specifies each platform-based logic by giving its key characteristics and leverage effects and lists the described examples from practice. These logics form the theoretical basis to analyze the lead actor's (i.e., manufacturer's) orchestration capabilities to ensure co-evolution of the platform.

[add Fig. 1 about here]

2.2 The platform actors' co-creation practices

Prior studies have emphasized platform leverage effects but give only limited theoretical guidance on how *all* platform actors can *jointly* exploit the platform's potential (Han, Martinez, & Neely, 2018; Lager, 2017; Mcintyre & Srinivasan, 2016; Thomas et al., 2014). In this sub-section, we argue that in addition to the lead actor's co-evolution efforts, *all* platform actors need to be involved to ensure platform leverage. As such, we take a multiple actor stand, and argue that value co-creation practices and the actors' concurrent input to unfold these practices lie at the basis of platform leverage effects.

In a B2B context, the co-creation of value is realized through interactions between a firm and its surrounding network composed of customers, suppliers and distributors (Jaakkola & Hakanen, 2013; Kohtamäki & Rajala, 2016; Lacoste, 2016; Marcos-Cuevas et al., 2016; Perks, Gruber, & Edvardsson, 2012). Value co-creation is understood as a 'joint, collaborative, concurrent, peer-like process of producing new value, both materially and symbolically' (Galvagno & Dalli, 2014, p.644). Value co-creation, therefore, extends across a two-way supplier-firm or firm-customer interactions to heterogeneous relations of artifacts, processes, interfaces, and persons (Ramaswamy & Ozcan, 2018).

Because value co-creation is difficult to observe (Storbacka et al., 2016), research calls for an increased attention to its micro-foundations (Storbacka et al., 2016). Value co-creation practices are such micro-foundations (Kohtamäki & Rajala, 2016). They refer to the activities of and interactions between network actors to eventually co-create value (Frow et al., 2016; Kohtamäki & Rajala, 2016). Co-creation practices allow us to better understand how interaction and resource sharing between different actors comes about (de Oliveira & Cortimiglia, 2017). A variety of co-creation practices can be observed depending on the firm's operating process stage (Zaborek & Mazur, 2019). For instance, firms at the production side of the value chain might contribute to value co-creation via co-diagnosing or co-manufacturing (Rayna, Striukova, & Darlington, 2015), while firms active at the commercialization side might be active in co-ideation or co-problem solving (Kohtamäki & Rajala, 2016). Scholars argued that activities such as knowledge sharing and co-innovation are essential in the value co-creation process for firms at any side of the value chain (e.g., Markovic & Bagherzadeh, 2018).

Actors intending to co-create need the capability to provide the necessary input allowing for co-creation (Aarikka-Stenroos & Jaakkola, 2012; Laczko, Hullova, Needham, Rossiter, & Battisti, 2019; Parida, Burström, Visnjic, & Wincent, 2019; Sjödin, Parida, Kohtamäki, & Wincent, 2020). Grönroos (2008), for example, argues that the input an actor can provide defines its role and position in the joint value creation process. Thus, it allows the actors to participate in co-creation. This is also reflected in the Actors-Resources-Activities model (Hakansson & Johanson, 1992; Hakansson & Shenota, 1995; Lenney & Easton, 2009). Actors carry out activities with other actors, for which they need resources to be able to optimally create additional value (Breidbach & Maglio, 2016).

To summarize, we posit that co-evolution is indispensable to ensure external alignment between the lead actor (i.e., the manufacturer) and the other platform actors involved. To ensure co-evolution, we follow the theory on collaborative settings and argue that orchestration capabilities are indispensable. In addition, we adopt insights from literature on co-creation and argue that to further exploit the potential of platforms, actors need to adopt co-creation practices and provide the needed input such as specialist skills and techniques to enable this process. Which orchestration capabilities are needed for co-evolution, and how the different actors' input and co-creation practices are tied together to allow for platform development and leverage, however, it remains unclear. To guide the reader through the main theoretical building components used in this paper, we refer to Appendix A, where a definitional overview of the constructs 'platform leverage logics', 'platform development stages', 'orchestration capabilities', and 'value co-creation' (i.e., co-creation practices and co-creation input) can be found.

3 Methodology

3.1 Research context and case selection

A qualitative research format is chosen because the topic of platform leverage is scarcely explored and a qualitative research design allows us to uncover new relationships among key dimensions (Matthyssens & Vandenbempt, 2003). Therefore, we respond to Möller and Halinen's (2017) call for more qualitative studies that investigate the dynamic development of a platform, rather than carrying out studies only capturing a single instance or occasion. We focus on one specific context, the Chinese textile industry, in which we gather rich data about four purposefully selected cases.

This industry is one of the sectors that benefits most from digital technology such as IoT and digital platforms (Lola & Bakeev, 2019). Moreover, it is one of the largest traditionally 'low-tech' industries in China (Kirner et al., 2009; Mendonça, 2009; Yang & Zhong, 1998). Challenged by a long period of economic crisis and ever-shrinking labor supply, Chinese textile firms are searching for ways to strengthen their competitive market positions (Chen & Xing, 2015). The Chinese government has initiated the 'Made in China (MiC) 2025 plan' (Li, 2018), which is partly inspired by Germany's Industry 4.0 initiative, seeking to move China from a low-cost manufacturer to a direct added-value competitor. Inspired by the MiC 2025 plan, some pioneer Chinese textile firms have undertaken a series of intense platform-based value co-creation practices that strengthen the use of local resources, exploit advanced manufacturing techniques and open cross-sectorial collaborations and strategic network clusters (Hu, Huang, Zeng, & Zhang, 2016; Li & Chen, 2018).

Accordingly, by focusing on the Chinese textile industry, we respond to Möller and Halinen's (2017) quest for platform research in more specific fields and Frow, Nenonen, Payne and Storbacka's (2015) call for in-depth case studies about the lead actor's implementation process to coordinate platform actors during value co-creation. We follow propositions to perform in-depth strategic management studies and cases on firms adopting a digital transformation strategy in an Industry 4.0 environment (Ghobakhloo, 2018; Pagani & Pardo, 2017).

Our empirical database consists of data on four large textile firms located in textile clusters within the Yangtze River Delta and the Bohai Rim Region of East China. The textile industry in these regions has increased attention for technological innovation, industrial upgrading and improvement of the industrial chain (Bai & Liu, 2013; Zhou & Wan, 2017). Our purposeful sampling criteria focus on selecting firms (1) with characteristics of platform-type operations, (2) which have consistently applied value co-creation practices when developing their platform-based logics, and (3) which are large organizations. More specifically, regarding the first sampling criterion, we checked whether the firms had followed a path towards becoming an integrated Smart Factory with attention for both front- and back-end operation modularization (Cenamor et al., 2017; Eloranta & Turunen, 2016;

Strozzi et al., 2017). They also had to have an ICT-enabled structure in place to strengthen reciprocal exchange of data and knowledge (Kowalkowski, Ridell, Röndell, & Sörhammar, 2012).

Regarding the second sampling criterion, we checked whether the firms engaged their supply-chain partners and customers during value creation (Marcos-Cuevas et al., 2016). We were able to find firms complying to the first and the second sampling criterion within the group of firms listed by external industry experts as pioneers of the '2017 China smart manufacturing pilot demonstration project in the textile industry'. Within this group of firms, we only selected large manufacturers defined as the Ministry of Industry and Information Technology in China. i.e., firms with over 1,000 employees or an annual total revenue of more than CNY 400 million, i.e., about USD 57 million. We purposefully selected large manufacturers because most smaller ones are not ready for full digital transformation (Ghobakhloo, 2018). The inclusion of smaller players would thus have limited the platform transformation areas, and consequently the potential theoretical insights originating from our empirical study.

The four selected firms developed their businesses in industrial clusters specialized in textile products in the Zhejiang province (in the Yangtze River Delta) and the Shandong province (in the Bohai Rim Region). Two of them are fiber manufacturers (i.e., Huading and Huaxing) positioned at the first stage of the textile and apparel value chain (i.e., extracting raw material and developing new synthetic fibers and fabrics) and the other two are apparel manufacturers (i.e., KuteSmart and Ruyi) placed at the second stage of the textile and apparel value chain (i.e., usually producing standardized outputs such as apparel). Thus, they add value to the first primary manufacturing stage during their production process. The four textile firms are production-oriented manufacturers who responded to the call of the MiC 2025 initiative and restructured their business towards becoming a Smart Factory, and also adopt digital commerce. They gradually developed their focus towards a platform logic and are considered established examples of a successful transition towards IoT business models. Their main features, as well as the platform logics the four firms focus on, are presented in Table 1.

[add Table 1 about here]

3.2 Data collection

We have collected data via various sources. First, we gathered secondary data about smart production / digital transaction developments in the textile industry from university, government and institute reports. Next, we gathered secondary data on our four cases via an Internet search and firm specific documents. We developed firm identity cards containing descriptive information such as their founding years or industry focus (see also Table 1) and received access to firm presentations and strategic plans via their CEOs and managers in the frame of a multidisciplinary high level study on smart manufacturing development strategies in China's textile industry. Next, interviews and observations, joint meetings, and visits to the case companies were utilized to gather primary data. Additionally, we gathered secondary data about the companies' strategic developments from company reports given during company visits, and CEO slide presentations at a workshop that we organized with a multidisciplinary group of colleagues from Donghua University's SMDS Research Group. For the issues that needed further clarification and confirmation, we contacted the respondents through emails, instant messages and telephone discussions. The gathering of both primary and secondary data allowed us to execute a detailed analysis of the phenomenon under investigation and to adopt a comparative multiple-case study design (Eisenhardt, 1989; Yin, 1994). Comparative case studies allow us to probe into the specificities of an emerging research domain (Eisenhardt & Graebner, 2007), in our case platform development and leverage.

The interviews were conducted with divisional representatives of the case companies through panel discussions/workshops followed up by interviews and conversations with managers in the margin of conferences and company visits. The in-depth interviews followed a semi-structured questionnaire with open questions (Patton, 1990). During these interviews, we discussed the firm's targeted platform logic and its associated value co-creation practices. The interview consisted of three parts with two overarching questions for each part. The first part of the semi-structured questionnaire focused on challenges. Here, we discussed the following questions: *'What challenges and problems does the firm encounter?'*, and *'Why does the platform approach seems appropriate to address these problems?'*. The second part focused on solutions. Here we discussed the following overarching questions: *'What platform strategies does the firm undertake, in particular with regard to initial innovations, and subsequent evolutions?'*, and *'How does the firm use value co-creation practices to reach a solution?'*. The third part focused on outcomes. The following questions were asked: *'How has the platform logic made a difference to the firm's business?'*, and *'What facts and figures illustrate the impact of the platform logic on the firm's business?'*. Follow-up and clarifying questions were asked whenever necessary.

We carefully selected interviewees knowledgeable on the topic under investigation, i.e. they needed to have insights about the firm's strategic developments. In practice, this meant that we discussed our semi-structured interview questionnaire with representatives from top management, the marketing department and the production department (see Table 2 for profiles of participating managers/divisions). This ensured a thorough understanding of the firm's platform development and the actors' drivers, inhibitors and co-creation practices while trying to leverage the platform logic. During each interview, conversation, workshop or panel discussion, the researchers took notes which were summarized and translated into English by university assistants proficient both in English and Chinese.

[add Table 2 about here]

3.3 Data analysis method

We adopted a systematic combining approach (Dubois & Gadde, 2002) to analyze our rich dataset in relation to existing theory. It is ‘a process where theoretical framework, empirical fieldwork, and case analysis evolve simultaneously’ (Dubois & Gadde, 2002, p.554). It is a constant comparison technique, where the researcher simultaneously collects and analyzes data, implying that empirical results are complemented with theoretical insights in an iterative process. As such, we interchanged data to theory, whenever appropriate, to find additional explanations of what was observed and further close theoretical gaps. Ergo, it is an appropriate technique to uncover relationships in the data, link these relationships to overarching themes, and finally align or extend theoretical models (Glaser, 1965).

We deliberately used a semi-structured questionnaire (see previous section) because this allowed us to pursue specific themes in the interviews while staying open-minded to new ideas and topics (Charmaz, 2006). To analyze our rich dataset, we adopted an open coding approach facilitated by the Atlas.ti 8 software. This implies that we worked with several coding rounds. During the first round, we coded the interview transcripts and field notes line by line, searching for relevant ‘open codes’ in relation to our topic of interest. Combining these open codes with the secondary data gathered through, e.g., e-mails, reports, company presentations, firm websites and reports, resulted in our first-order categories. We continued this process until no new information was originating from the data and the saturation point was reached. To ensure this, we systematically checked whether previously coded text and newly created codes were ‘relevant for developing and refining theoretical categories or central concepts’ (Bowen, 2008, p.139). After this initial coding process, we moved to axial coding. This means that we searched for relationships between categories (Strauss & Corbin, 1990) and that we developed second-order themes. Finally, during a third analysis round, we aggregated all dimensions into overarching theoretical themes. We discussed the data structure among all researchers involved to ensure data analysis reliability. A final analysis report was sent to each case company for control of accuracy.

4 Case summaries

This section provides an answer to major questions such as: How did the selected case firms develop their platform logic? How did the lead actor ensure co-evolution during platform development, and how did co-creation occur among all platform actors?

4.1 Huading: nylon filament supplier armed with a smart factory and cross-border customer interaction platform

Huading is a leading manufacturer and supplier in China's nylon filament sector. Inspired by the government's call to upgrade traditional manufacturing by digital technology, the firm adopted a dual strategy. It established a platform-based Smart Factory producing nylon filament and developed a cross-border customer interaction platform for the B2B market. By doing so, the company did not only address a labor shortage problem they were facing at that time but also improved response time to customer requests.

Huading gradually transformed to a platform-based Smart Factory. In 2015, Huading started to cooperate with suppliers and technology partners. As one of the interviewees (i.e., HD4) recalled, digital technology experts suggested developing a Smart Factory. To do so, Huading actively pursued collaboration with global machine suppliers resulting in the development of a joint plan of action. This allowed them to jointly develop advanced production equipment and set up programs to ensure close collaboration between the suppliers and Huading's production team. At a certain moment, Huading started to develop a manufacturing platform with an integrated operating system and stimulated innovations with technology partners. For example, Huading established an innovation community to reward innovative ideas and share useful innovation-related skills. By doing so, they cultivated a group of high-quality talents in the fiber field. Finally, in 2017, Huading successfully launched the integrated operating system and enabled supply chain partners to jointly analyze operating data and stimulate the development of digital applications.

Adopting a cross-border customer interaction platform was a logical next choice, once the platform-based Smart Factory was developed. More specifically, Huading leveraged its expertise in digital production and developed itself as a solution provider. The customer interaction platform they adopted did not only allow them to quickly respond to market changes, but also minimized the risks of raw material price fluctuations. Thanks to the acquisition of a cross-border e-commerce firm, Huading was able to get a license to enter the global market. Overall, the customer interaction platform allowed Huading to directly interact with customers, recognize and address their problems, translate their needs into product features, and – ultimately – increase customer experiences and generate increased revenue.

4.2 Huaxing: establisher of smart spinning factories adding customer-centric interaction

Huaxing is the national leader in the cotton spinning sector. Taking advantage of the opportunities provided by Industry 4.0, Huaxing transformed itself from a traditionally labor-intensive firm into a platform-based, smart manufacturing and customer-centric business. In 2014, Huaxing selected a few strategic partners (suppliers) to develop platform-based Smart-spinning Factories. These factories allowed Huaxing to enhance efficiency and reduce labor costs. For example, they increased cooperation with manufacturing equipment suppliers to jointly diagnose the key technologies for digital production and built up an innovation community to be able to reward innovative initiatives.

Their work with suppliers and technology partners eventually led to the development of an Integrated Cyber-Physical System (ICPS). This system, developed in close collaboration with software suppliers and industry experts, operates right in the center of the manufacturing platform and enables communication and collaboration across production units. Together with technology partners, Huaxing was able to develop a large amount of ICPS-related solutions, such as a cloud-based big data analytics tool which enables suppliers to co-analyze operating data and alert operation risks.

Huaxing promoted co-problem solving activities with supply chain partners into this ICPS-based manufacturing platform. For instance, they held face-to-face meetings with suppliers initially hesitant to join the platform and co-developed solutions with technology partners, to address potential problems. According to one of the interviewees (i.e., HX3), Huaxing also leveraged its smart spinning expertise to Small and Medium-sized Enterprises (i.e., SMEs) in their supply chain. As such, they facilitated SMEs in their Smart Factory transformation process and extended the SMEs' role from supplier to potential customer. This led to an increase in revenue for Huaxing.

In addition, Huaxing set up a B2B customer interaction platform to improve customer relationships. The customer interaction platform created a virtual connection between Huaxing and its (potential) customers and created mutual benefits which not only enhanced customer experiences but also offered Huaxing the necessary means and opportunities to collect customer data. In the coming years, Huaxing aims to integrate all customer orders placed in the customer interaction platform with the firm's production system. As such, they hope to be able to quickly respond to changing customer demands and further customize the solutions offered.

4.3 KuteSmart: mass customization platform builder and smart factory solution provider

KuteSmart is a global supplier of customized apparel. In 2011, after one of its recurring evaluation meetings with technology partners and suppliers about the industry's opportunities and threats and the platform's value, KuteSmart decided to reconfigure the production process and enable mass customization of men's suits. To do so, they transformed into a Smart Factory allowing them to respond to customers' calls for 'making customization no longer a luxury'. According to one of the interviewees (i.e., KS4), initially it was not easy to ensure co-commitment of all partners on the Smart Factory development, and a lot of negotiations with suppliers and technology partners were necessary to reach co-commitment on this goal. During the Smart Factory's development phase, KuteSmart placed specific attention to joint innovation activities with technology partners (e.g., in co-designing and co-developing the digital assembly line), as well as for IoT devices such as RFID-enabled tags linking human workers, machines and products.

Developing a production process enabling mass customization requires a data-driven, flexible supply chain, for which KuteSmart collaborated with supply chain partners and software developers. They enabled and encouraged co-sharing activities such as data storing and data sharing and provided the necessary (software) material required. In addition, to strengthen the platform actors' ability to develop new technologies, cross-sector collaboration was fostered more vigorously. For example, one of the interviewees (i.e., KS7) explained that apparel designers, material suppliers and software developers all worked together to develop a cloud-based analysis method to enable autonomous 3D modeling of customized products. Consequently, KuteSmart increased its attention for trust building among its partners. For example, they set up and carried out a set of collaborative rules to ensure and manage openness and sustain long-term innovations.

In 2016, KuteSmart's mass customization platform was launched, supporting customers to access supply side data, and self-design and modify every detail in real-time communication with the factory.

Today, KuteSmart stands for enhanced efficiency, great experience and value innovation. Thanks to the platform-based mass customization business, KuteSmart transformed into an Industry 4.0 solution provider. They do not only create more value for customers but also serve as a digital knowledge and skills consultant supporting other industrial manufacturers in their digital transformation process.

4.4 Ruyi: builder of a vertically integrated supply chain adding mass customization

Ruyi is a global business providing wool textile and apparel products serving a wide range of luxury brands. Considering customers' requirements for product improvement and lead time reduction, Ruyi established a cloud-based Smart Factory and a customization platform offering flexible and individualized services. For the development of the Smart Factory, Ruyi promoted linkages with technology partners, machine suppliers and research institutes. To achieve joint goal development, they organized a series of meetings among potential platform partners. Thereafter, Ruyi developed a 'talent network' program to link both internal and external knowledge resources and increase open innovation in the area of cloud-based, collaborative manufacturing.

For the development of the mass customization platform, Ruyi set up collaborations with worldwide apparel designers and technology partners. To ensure smooth cooperation, they placed specific attention to trust building among these partners and set up clear cooperation rules. Partners were encouraged to co-develop advanced applications (e.g., data models and analysis methods to translate customer data into demand forecasts), address customers' issues (e.g., to ensure self-measurement) and create innovative services (e.g., to provide illustrative guidelines and tour videos for platform users). Customers were encouraged to share feedback and knowledge regarding usage of the customization platform.

To ensure that the platform leverage effect was also beneficial in terms of revenue, in 2018 Ruyi set up a strategic cooperation and developed a smart retail business with Secoo, a global luxury e-commerce firm listed on the Nasdaq stock market. According to the vice president (i.e., RY4), Ruyi and Secoo shared business resources to develop a 'Manufacturer to Brand to Customer' (M2B2C) service. They aimed to integrate their supply chain networks and brand assets to be able to serve high-end customers' individualized needs. The M2B2C service also created additional customer channels to deliver specialized industry knowledge and allowed the integration of customer feedback and comments into new products and services. To address value conflicts caused by, e.g., cultural and organizational differences between Ruyi and Secoo, Ruyi adjusted and optimized its overseas cooperation management practices. They did so via an incremental integration process. More specifically, Ruyi initially positioned itself as one of Secoo's strategic partners, and gradually transformed itself into its operational overseas collaborator. Due to this gradual shift, they were able to timely detect and address cultural and organizational differences.

5 Discussion

5.1 Orchestration capabilities taxonomy

5.1.1 Platform development stages

Platform development seems to occur in three stages which we labeled a platform initiating stage, a platform transitioning, and a platform strengthening stage, see Fig. 2, Y axis. Interestingly, these stages seem to be prevalent in our data irrespective of the type of platform logic being developed. In the *'platform initiating'* stage, Huading initially had few partners able to participate in the firm's transformation into a Smart Factory. To address this, they started to connect with equipment and IT suppliers to generate ideas about digital production processes. Frow et al. (2016) discuss that there is often a specific need for searching new partners to co-develop ideas in the initial stages of collaborative settings when firms often have a limited amount of known partners. Marcos-Cuevas et al. (2016) refer to this stage as 'linking' which implies that a lead actor tries to locate the necessary partners to pursue its strategic goals.

After the initiating stage, lead actors enter the *'platform transitioning'* stage and start to scale and refine their business model. Participating companies experienced tensions among platform actors and found out that rules were necessary to prevent such problems from holding back platform development. KuteSmart, for example, explained that they set rules to control the innovation network. Eloranta and Turunen (2016) explain that with an increase of participants and a more diverse industry structure, also complexity-related challenges arise.

Trust building and clear positioning of each platform actor were used by the case companies to move to the platform transitioning stage. Kumaraswamy, Garud and Ansari (2018) even argue that around the platform, a new viable ecosystem should be developed, including shared norms and standards among all platform actors. Given that in our cases joint innovations received additional attention (e.g., government funding, awards), it became apparent that the lead actors were trying to develop such joint norms and standards. Marcos-Cuevas et al. (2016) argue that development of a shared language can ensure the continuous capturing and retaining of the value created. It results in the institutionalization of a platform logic.

In the next stage, labeled the *'platform strengthening'* stage, we see that the lead actors try to ensure a successful long-term collaboration among all platform actors. Relationship management becomes key. For example, Ruyi focused on the further strengthening of its relationship with its overseas strategic partner and enhanced their integration of their existing business processes. In the platform strengthening stage, more investments are needed to ensure the functioning of operational practices and smoothen collaboration. This is also referred to as 'materializing' by Marcos-Cuevas et al. (2016), which implies that the platform becomes mature (Teece, 2017). In Kohtamäki and Rajala's (2016) B2B value creation typology it is argued that from the moment that suppliers and customers operate in close collaboration, a close follow-up of the relationships and successful management and business processes becomes critical to sustain the value created.

[Insert Fig. 2 about here]

5.1.2 Orchestration capabilities

To ensure that all platform actors co-evolve along these three development stages, our data (see Appendix B, C, D) revealed three ‘higher order’ orchestration capabilities, visually portrayed in the X-axis of Fig. 2:

- A targeting capability, which is defined as a firm’s ability to direct resource deployment and development initiatives in quality management, product design, marketing (Francis & Bessant, 2005; Helfat & Raubitschek, 2018; Paquin & Howard-Grenville, 2013);
- A legitimizing and envisioning capability, which refers to the ability to establish commitments, legitimacy, social contracts between participants, and provide actors with visionary ideas (Paquin & Howard-Grenville, 2013; Perks et al., 2017); and
- An expertise building capability, which is considered as the ability to identify, activate, collect, and coordinate knowledge resources (Aarikka-Stenroos & Jaakkola, 2012; Nätti, Hurmelinna-Laukkanen, & Johnston, 2014; Perks et al., 2017).

Interestingly, we uncovered that in *each* stage, these orchestration capabilities are necessary to ensure co-evolution, albeit with a different interpretation depending on the stage. We visualize these interpretations in the nine cells of Fig. 2, see columns two to four, and progressively explore them in what follows.

As explained by Francis and Bessant (2005), the first higher order orchestration capability *'targeting capability'* is a steppingstone towards innovation (see Fig. 2, second column). It refers to defining the role the organization will pursue and the offerings it will provide (Francis & Bessant, 2005). The case data supports this idea and illustrates that in a platform context, this capability relates to evaluating the platform's potential benefits in the platform initiating stage (see cell 1 of Fig. 2), redefining each platform member's position in the value chain in the platform transitioning stage (see cell 2 of Fig. 2), and selecting partners that have most value to the platform network and reinforcing ties between them (see cell 3 of Fig. 2). Indeed, our data illustrates that in the platform initiating stage, KuteSmart invested time and money to evaluate both the potential and the costs of adopting a platform-based logic before making the strategic decision to pursue a platform logic (see Appendix B, KS5). Once the platform develops further and is in the platform transitioning stage, the targeting capability focuses more on a redefinition of all platform actors in the value chain. For example, after implementing the digital nylon factory, Huading decided to shift from a producer to a digital solution provider. This decision impacted its position in the value chain (see Appendix B, HD6). Another example is Huaxing, this firm intended to upgrade its position from a product manufacturer to an integrated solution provider and turned previous suppliers into potential customers to create additional revenue (see Appendix B, HX3). Finally, in the platform strengthening stage, the capability to select those partners that can add most value to the entire network becomes more important. For example, as RY3 recalled, Secoo has mature online and offline sales channels and plentiful high-end customers (see Appendix B, RY3). This explains why Secoo was chosen to be Ruyi's best collaborator for the smart retail business.

When analyzing the second higher order orchestration capability *'legitimizing and envisioning capability'* (see Fig. 2, third column), our data portrayed that in the platform initiating stage, a focus on continued coordination among platform actors to set and legitimize a common goal is key. As also suggested by Nambisan and Sawney (2011) and Perks et al. (2017), a joint goal and subsequent resource provision is pivotal in this stage. This needs to be orchestrated by the platform's lead actor. Recurring meetings and enthusing platform members are indispensable. For example, Ruyi, Huaxing and Huading tried to create opportunities such as hosting events and workshops to bring together potential platform collaborators and derive a joint goal (see, for example, Appendix C, RY2). According to the managers interviewed, in the platform transitioning stage, developing trust among the platform actors is key. To this end, Ruyi and KuteSmart started to focus on 'making rules beforehand' (see Appendix C, RY6) to 'sustain long term cooperation' (see Appendix C, KS1). Finally, in the platform strengthening stage, the ability to handle and manage value conflicts became relatively more important. Ruyi invested time and resources to handle overseas business integration. As explained, they first took up a strategic partner role and gradually transformed into an operational collaborator. This allowed them to manage and solve conflicts about national and corporate cultural differences (see Appendix C, RY4).

The third higher order orchestration capability is *'expertise building'* (see Fig. 2, fourth column). More specifically, it is the ability to stimulate innovative ideas, introduce innovative services for problem-solving, and motivate the offering of knowledge-intensive services is required to facilitate value co-creation along platform development. This shows that the expertise building capability mainly resides in innovation stimulation. The importance of innovation for value creation is also stressed by Aarikka-Stenroos, Jaakkola, Harrison, and Mäkitalo-Keinonen (2017) and Nambisan and Sawney (2011).

If we probe further into the expertise building capability, we see that in the platform initiating stage, Huaxing and Huading provide rewards to trigger innovative outcomes within the platform (see Appendix D, HX2 and HD5). Such rewards are indispensable, as also explained by (Teece, 2017), who argues that in the initial stages of collaborative settings, co-innovators' adequate returns need to be secured. Rewards, which can be tangible (e.g., money) or intangible (e.g., recognition, feedback) portray the potential of collaborative innovation and value co-creation (Füller, 2010; Roser, De Fillippi, & Samson, 2013). In the platform transitioning stage, the platform orchestrator needs to ensure the introduction of innovative services for problem-solving. This is to ensure the rapid adjustment of the platform's operations in case problems arise. As such, value co-creation is further facilitated. Aarikka-Stenroos and Jaakkola (2012) also suggest that a problem-solving capability is prevalent during innovative solutions development. For example, one interviewee explained that Ruyi has 'integrated system designers to create illustrative guidelines and tour videos for users and invited customers who had successfully placed orders in the online system to summarize and share their experience and expertise in the platform' (see Appendix D, RY1). In doing so, they helped customers experiencing difficulties in using the online system. Finally, in the platform strengthening stage, it became apparent that the lead actor needs to develop the capability to offer professional knowledge intensive business services. KuteSmart, for example, collaborated with technology suppliers to generate technology-intensive services to assist material suppliers who lacked the necessary knowledge and skills to digitize product data (see Appendix D, KS2). As such, KuteSmart transformed itself into a solution provider, leveraging the platform logic to create additional revenues. The offering of such professional or knowledge intensive business services is corroborated in existing studies (e.g., Aarikka-Stenroos and Jaakkola, 2012).

5.2 Platform development process

In a traditional industry like the Chinese textile industry, forerunner firms seem to evolve gradually from being traditional, low-tech and production-oriented firms with an emphasis on optimizing back-end processes into high-tech firms paying attention to the exploitation of transaction / front-end leverage effects (see Fig. 3). To gradually evolve to another platform logic, orchestration capabilities are necessary to ensure co-evolution of all platform actors. We saw that in order to enhance and optimize the back-end manufacturing capacity of standard products, the manufacturers started employing digital tools and stimulating innovative ideas among platform actors (see cell 7 of Fig. 2). This is not surprising: In a fast-changing environment where digital technologies are widely applied in manufacturing processes, also a traditional industry such as the textile industry is expected to uncover the advantages of digitization (Storbacka, 2018).

Huaxing, Ruyi and Huading used smart machinery (e.g., robots) to adopt digital and autonomous production processes and KuteSmart reached full digital production and utilized IoT devices such as RFID-enabled tags to link human workers, machines and products. The latter company was able to attain an optimized workflow and faster lead times through this IoT based system. The advantages of such digital production changes are also corroborated in the literature. For example, Matt, Hess and Benlian (2015) argue that the integration and exploitation of digital technologies is beneficial for productivity increase and (incremental) value innovations, and Coreynen, Matthyssens, Vanderstraeten and van Witteloostuijn (2020) discuss that the adoption of digital technologies in operations allows firms to develop products customized to a wider market range.

Our case companies started adopting an *incremental innovation* stance. Innovations predominantly focused on the digitization of existing production processes. Huading, for example, digitalized its production factory of nylon filament, Huaxing digitalized its spinning factory, and KuteSmart developed a digital suit assembly line. Interestingly, the firm owners started to adopt more radical changes in the production process once they experienced the benefits of digitization. Lead actors seem to initiate the development of an integrated digital system to ensure collaboration in manufacturing and realize improvements in efficiency and flexibility. Second-order orchestration capabilities such as introducing innovative services for problems-solving become more and more important (see cell 8 from Fig. 2). As such, the manufacturers adopt a production-radical logic. This production-radical logic turned out to be a steppingstone to a more customer-centric platform logic (i.e., a transaction-incremental or a transaction-radical logic).

Once back-end production was optimized, the case firms started to develop more customer-centric offerings. The data revealed that to be able to do so, back-end production processes and supply units needed to be adaptable to demand changes. The observed firms developed flexible production processes allowing them to improve resource usage and production efficiency. For example, Ruyi used an integrated operating system to speed up on-demand production and reduce lead time. KuteSmart, Huading and Huaxing adopted an integrated manufacturing platform to facilitate production, and soon learned that they could leverage their experience to provide solutions to a new type of customers. For instance, Huaxing gradually involved its supply chain partners in the manufacturing platform, starting to offer them smart spinning solutions and services. Even though the orchestration capabilities discussed above are important for co-evolution of all platform actors irrespective of the platform logic, the cells in the lower right corner of Fig. 2 appear to be relatively more important for customer oriented platform logics (e.g., a relatively stronger focus on the offering of professional or knowledge intensive business services in a transaction logic, see cell 9 in Fig. 2).

A gradual shift towards the transaction side of the value chain is also prevalent in existing studies. Coreynen et al. (2017) and Jaakkola and Hakanen (2013), for example, describe that manufacturers exploit a shared collection of diversified and distributed manufacturing resources to support customer-centric and on-demand production. This shift from production towards transaction side reflects the product service continuum model by Oliva and Kallenberg (2003), who describe a continuous transition process of a manufacturer from product into service provider. Matthyssens and Vandenbempt (2010) showed how manufacturers develop service addition strategies by introducing higher degrees of customization and less tangible offerings. Expertise building capabilities come to the fore at that stage. As observed in Ruyi, after the construction of Smart factory, the firm strengthened the linkage with production and service partners to stimulate innovative and creative ideas, enabling Ruyi to enhance its expertise building capability.

Thus, after adapting back-end units to make them more adaptable to customer needs (and therefore transform into a production-radical logic) our case firms shifted their focus to front-end optimization. A possible explanation for such a shift is that all case firms have responded to the call of MiC 2025 in which China aims to move up the value chain and upgrade itself from the world's production workshop into a service-oriented manufacturing power (Chinadaily.com.cn, 2017). Interestingly, during this shift, we observed that they followed either a value-adding service route or a more integrated personalization solution. We observed that two of our cases' lead actors immediately adopted a transaction-radical logic (i.e., KuteSmart and Ruyi), while the other two lead actors (i.e., Huading and Huaxing) opted for a transaction-incremental logic.

In those cases where the lead actor opted for a transaction-incremental logic, digital commercialization channels were adopted. As a result, Huading and Huaxing aligned their value creation routines with the customer and focused on value-adding service offerings. This required the capacity to capture customers' demands, fulfill their needs and sustain good relationship with them, as also suggested by Jaakkola and Hakanen (2013). For example, our data shows that Huaxing and Huading developed a customer interaction platform allowing them to extend their commercial reach and improve their response time. Subsequently, these lead actors also developed analytic systems to translate customer-related data (e.g., behavior data, purchasing data, comment data) into product features and quality improvements leading to a competitive advantage in the market.

Finally, the cases where the manufacturer immediately opted for a transaction-radical logic (i.e., KuteSmart and Ruyi), integrated personalized solutions were offered. This led to a radical impact on the interaction processes between the different actors in the value chain. Both manufacturers developed a mass customization platform and involved customers in the process of individual production. Taking KuteSmart as an example, the close collaboration with technology partners allowed the firm to provide customized products and services for customers and further develop its customization business to offer knowledge-intensive business solutions for industrial partners who demanded for Industry 4.0 transformation. As such, firms were able to generate a quantum leap in value co-creation. Lu (2017) and Wu, Rosen, Wang and Schaefer (2015) show that thanks to digitization, manufacturers can leverage smart technology to develop advanced manufacturing models. This allows them to offer customers in-house manufacturing experience such as IT-enabled mass customization and cloud-based design and manufacturing. The case companies stress their intention to combine their existing product offerings while developing additional services. The co-existence of products and services might lead manufacturers to experience ambivalence (Lenka, Parida, Sjödin, & Wincent, 2018).

[Insert Fig. 3 about here]

5.3 Co-creation practices

The platform's lead actor (i.e., manufacturer) maintains the ultimate control of the network and stimulates the participating actors (i.e., suppliers / technology partners and customers) to take up a co-creating role for which they need to provide enough input. The lead actors stimulate joint co-creation among *all* platform actors in order to reach platform leverage. Overall, our data portrays seven co-creation practices: Co-diagnosis, co-problem solving, co-sharing, co-commitment, co-analyzing, co-innovation, and co-experience (Aarikka-Stenroos & Jaakkola, 2012; Frow et al., 2015; Kohtamäki & Partanen, 2016; Lee, Olson, & Trimi, 2012; Lenka, Parida, & Wincent, 2017; Marcos-Cuevas et al., 2016; Ranjan & Read, 2016; Reypens, Lievens, & Blazevic, 2016; Urbinati, Bogers, Chiesa, & Frattini, 2019; Xie, Wu, Xiao, & Hu, 2016).

Co-diagnosis, co-problem solving, co-sharing, and co-innovation turned out to be important for both customers and supplier / technology partners, which all turned out to be able to provide an active contribution. In contrast, suppliers and technology experts were named as being able to co-commit and co-analyze, while customers were said to be involved in co-experience (see Fig. 4 and Appendix E, F, G, H). These co-creation practices build on input from each partner type. From the supplier / technology partners input such as expert knowledge, professional facilities and interaction skills are required. Customers need to be able to clearly outline their needs, have technical skills (e.g., self-design skills and the ability to use the platform's software to ensure an optimal customer experience), have industry expertise to be able to provide useful feedback, and interaction skills to enhance firm-customer cooperation (see Fig. 4).

The importance of key players such as suppliers and customers to exert influence on the co-evolution and co-creation of platform logics is also apparent in existing literature (e.g., Zwass, 2010). Even though it is the lead actor who develops toolkits and services (Eloranta & Turunen, 2016), the importance of co-creator roles has also been stressed in previous studies, though with less detail. Aarikka-Stenroos and Jaakkola (2012), for example, explain that ten co-creator roles exist (i.e., value option advisor, value process organizer, value amplifier, value experience supporter, co-diagnoser, co-designer, co-producer, co-implementor, co-marketer, and co-developer) and twelve co-creator resources (i.e., expert knowledge, diagnosis skills, facilities, experiences, objectivity, relational capital, information on needs, information on context, industry expertise, production material, time, and financial resources).

In addition, we find that different input seems to be required for incremental versus radical innovations. For incremental innovations, expert knowledge about the existing products, processes, technologies, organizational structure and methods turned out to be pivotal. The lead actors (i.e., the manufacturers) stressed that they counted on the suppliers / technology partners' project management skills, specialist skills and techniques to ensure co-diagnosis, co-problem solving, co-sharing and co-commitment of existing products, processes, technologies, organizational structure and methods.

5.3.1 Supplier / technology partner co-creation practices

The importance of suppliers and technology partners during incremental innovations has been discussed by Forés and Camisón (2016), who stress that for incremental innovation, most ideas come from the external environment. In addition, because a firm's back-end work is often sealed off from customer contacts, the production-incremental logic focuses more on production improvements (Broekhuis, De Blok, & Meijboom, 2009). Our empirical data uncovers that for this, suppliers need to provide professional facilities such as advanced machine tools and equipment for co-innovation. One of the interviewees (i.e., HD1) discusses: 'We introduced a set of advanced machine tools and equipment imported from Italy, Belgium, Switzerland and Germany and kept stable connections with these machine suppliers, as the equipment application and maintenance required constant and mutual collaboration' (see Appendix H, HD1 under co-innovation). Here, suppliers' professional facilities are considered as the physical building components of a manufacturing platform and Smart Factory enabling suppliers to contribute in co-creation thanks to their expertise.

To attain radical innovations, firms need to introduce next-generation technologies (e.g., IoT data sharing and analysis) having the potential to break the established linkages of dominant current ecosystems. In the production-radical logic, we find that suppliers are required to assist the manufacturer with data identification, gathering, and analysis. For example, one of the interviewees (i.e., HX4) discussed that 'with the specific ICPS-related solutions in place, the ICPS control center paved the way together with supply chain partners to analyze the captured real-time information and alert operation risks' (see Appendix E, HX4 under co-analyzing).

In addition, we found that there was relatively more need for searching for and getting acquainted with new partners and ideas. This required interaction skills such as a proactive attitude and partner understanding. This was discussed by RY5, who explained that within the platform, they stimulated innovative idea development among suppliers: 'We have broken new boundaries when it comes to creating innovations. Under our talent network program, both internal and external knowledge resources were interlinked' (see Appendix H, RY5 under co-innovation). Interaction skills and technological expertise enabled suppliers to play the role of co-analyzer and co-innovator, as such contributing to the generation of radical innovative solutions.

5.3.2 Customer co-creation practices

In a transaction-incremental logic, it is the customer who can provide most input during the value creating process (Coreynen et al., 2017). We find that in this logic, the customer acts as a co-experiencer. To be able to do so, we find that customers also act as co-diagnosers, co-problem solvers, co-sharers and co-innovators. Huading, for example, explained that customers need to voice their problems and need to be able to meaningfully contribute to co-creation. One of its interviewees (i.e., HD2) explained: 'The e-commerce created channels between customers and us which allowed us to interact with customers and address their problems, providing them good online shopping experience'. In Huaxing, interviewee HX6 mentioned that they welcomed customers' voices and extended digital channels to collect customer information (see Appendix G, HD2 and HX6 under co-experience).

Finally, in a transaction-radical logic, innovations are typically new to the market (i.e., the customers) as opposed to incremental innovations which are typically new to the firm (Snyder, Witell, Gustafsson, Fombelle, & Kristensson, 2016). We uncover in our data that in a transaction-radical logic there is explicit attention towards the creation of new customer benefits (e.g., by creating customization opportunities and translating individualized requirements into integrated offerings).

For example, KuteSmart developed an online platform to co-design individualized products with customers. Customers were able to contribute in co-creation as co-sharers if they developed the ability to use the firm's software (e.g., website and mobile application) and developed digital self-design skills. As such, they could communicate their needs. Eventually, this resulted in the design of personalized products (see Appendix E, KS1 under co-sharing, and Appendix G, HX6 under co-experience). radical innovation required the emergence of a new value system. Therefore, firms need a larger network and unknown partners to co-develop rich ideas. For this, mobilizing customer connections and networks is pivotal. This is also apparent in Ruyi, who built voice channels for high-end customers to deliver specialized industry knowledge, feedbacks and comments on new products or services, as such stimulating innovative solutions for luxury retail. In addition, interaction skills are important for customers to enhance cooperation with firms. For instance, interviewee RY4 mentioned that Ruyi and Secoo had taken on a proactive and inventive attitude to business resource integration. This attitude was believed to stimulate the creation of new offerings of M2B2C service and, consequently, performances of the firms.

[Insert Fig. 4 about here]

6 Conclusion

In this study, we set out an empirical study in a traditional industry to uncover the underlying building components of platform development and leverage. To do so, we adopted the co-evolution concept and its concurrent orchestration capabilities from network theory to better understand platform development. In addition, we argued that next to co-evolution, co-creation among all platform actors is pivotal to ensure platform leverage. Based on a multiple-case study involving four illustrative cases from the traditional Chinese textile industry, three higher order orchestration capabilities were explored to enable platform co-evolution and seven co-creation practices were identified. Supporting firms were mobilized through these co-creation practices to jointly exploit and leverage the potential of platforms during the transition from production-oriented to transaction-oriented platform logics. Overall, our empirical study uncovered four overarching contributions to theory.

First, we clearly saw a gradual transition between platforms. In a traditional industry such as the textile industry, manufacturers first attribute attention to the development of the back-end processes (i.e., production) by focusing on incremental innovations. Only after they transitioned towards a production-radical logic, they start to pay more attention to specific customer needs and a transaction logic. Interestingly, once the platform starts to transition towards a transaction logic, two options are equally possible: An immediate focus on a transaction-radical logic, or a focus on a transaction-incremental logic. This finding portrays that our theoretical extension of Thomas et al.'s (2014) architectural leverage logic into two dimensions (i.e., incremental versus radical innovation, and transaction versus production focus) is also visible in the empirical data. Furthermore, the gradual shift between logics can be traced back to network theory, where it is argued that network components constantly recombine to achieve a better fit with environmental changes (Tiwana et al., 2010), in our case an ever more digitalizing world.

Second, there is a ‘spiraling up’ process during platform development. There are three platform development stages, irrespective of the type of platform logic the lead actor is focusing on: A platform initiating, a platform transitioning, and a platform strengthening stage. In addition, platform development occurs gradually and often requires considerable effort from the lead actor (i.e., the manufacturer). For example, the lead actor needs to search for adequate platform partners, ensure trust building between all platform actors, develop a shared platform language, and clearly position all platform actors in the platform’s value chain.

Thirdly, the overarching theoretical contribution: Platform development and co-evolving of all platform actors is only possible due to the manufacturer's orchestration capabilities. Specific orchestration capabilities are required to enable co-evolution (Matthyssens et al., 2009). There are three orchestration capabilities: Targeting, legitimizing & envisioning, and expertise building. Interestingly, each of these capabilities is required in each platform development stage, albeit with a different interpretation depending on the stage, and with a relative stronger focus on the expertise building capability when platforms transform to transaction logics.

A final contribution resides around the required input from all platform actors to ensure co-creation. Each platform actor type (i.e., customers and suppliers / technology partners) needs to perform co-creating practices and provide the necessary input to ensure that co-creation practices can leverage a platform's potential, which was also suggested by Thomas et al. (2014). Which input is needed, is dependent upon the type of platform logic. More specifically, a radical innovation logic needs, e.g., a proactive attitude and industry-specific knowledge, while an incremental logic needs, e.g., project management skills and clear needs setting. The required input thus does not only differ depending on the co-creating practices and the development of a back- or front-end platform, but also on whether the platforms focuses on radical versus incremental innovation.

6.1 Managerial implications

A platform-based logic is frequently adopted by industrial firms to facilitate innovations and add more value to the offering via inter-firm collaboration. This article clearly shows the potential leveraging effect of platforms and reminds managers to build and exploit the necessary orchestration capabilities and value co-creation practices. Based on the case studies described in this article, it illustrates that the orchestration capabilities necessary to develop a platform are prevalent in the data irrespective of the type of platform logic being developed.

In addition, our study also suggests that to leverage platform logics, having specific attention to incremental innovation (i.e., the production-incremental and transaction-incremental logic), it is recommended to develop value co-creation input focusing on expert knowledge and needs settings. As opposed to the needed input for platform leverage with radical innovations, which resides around interaction skills, technological expertise (i.e., fine-grained analytic skills and techniques), production-related skills, and in-depth industry expertise. These findings could help firms to alter their focal strategy for resource development when shifting from an incremental to a radical platform logic.

Finally, this study does not only identify three development stages for platform development but also identifies a platform-based development 'route' across platform leverage logics. All our case firms started from offering standard products, after which they shifted their attention to customer-centric offerings, some of them even with radical innovations. Focusing on value-adding services and integrated personalized solutions allows managers to answer to a transaction-based (front-end) platform logic. This study can inspire managers intending to follow such transitioning routes. The frameworks designed on the basis of literature and the routes our case firms followed can guide managers through a structured process of (a) outlining the starting position and stipulating the intended path along the platform leverage logics (Fig. 1), (b) detailing the platform development stages and the orchestration capabilities necessary to ensure co-evolution between platform actors while transitioning from a platform initiating to a platform strengthening stage (Fig. 2 and 3), and (c) building a mix of co-creation practices towards suppliers/technology partners and customers enabling each of these platform actor types to perform appropriate co-creating practices thereby ensuring the leverage of a platform's potential (Fig. 4). Manufacturers could use these insights to work out a platform development approach.

6.2 Limitations and suggestions for future research

Building on the theoretical reasoning and qualitative research, this article provides expanded insight into how manufacturers are using platform approaches to co-create value in the age of Industry 4.0, but it cannot claim generalizability given its qualitative research method. Even though our choice for a qualitative approach is justified given the specific context we research, we urge future researchers to adopt quantitative approaches as well, allowing for further generalization of the results. More specifically, the effectiveness of specific configurations of co-creation practices at different stages of platform development warrants additional attention. Also, the effect of different orchestration 'triggers' to stimulate co-evolution across industries and platform types merits further research.

Second, this study focuses on orchestration capabilities and value co-creation, without considering other capabilities, such as dynamic capabilities. Future research could identify the specific internal capabilities necessary for manufacturers to control the platform and sustain the value co-creation process. A multilevel theory lens might be valuable in this regard given that, besides network development and mobilization capabilities, also dynamic capabilities for platform-based strategic innovation and customer/supplier interaction and co-evolution capabilities are required.

Third, though we purposefully selected firms from China's textile manufacturing industry as case illustrations, the use of platform methods can certainly be found in other industries as well. Investigating cases from other industries could well lead to different starting positions and platform leverage trajectories. Hence, different sets of dynamic value co-creation practices could be discovered, providing further valid contributions to the literature. Thereby we recommend comparing the platform development routes of companies with different strategic paths in the platform logics framework (Fig. 1). As the value co-creation process is dynamic and iterative in nature, a longitudinal method which allows mapping and explaining simultaneous changes of value co-creation practices and orchestration capabilities within and between firms might be required. The longitudinal approach is considered particularly suitable to investigate process changes in inter-firm platform settings and to uncover learning processes.

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Appendix A: Concept clarification

Concept	Dimension	Description	References
Platform leverage logic	Production-incremental logic	Using platforms to upgrade production and logistic activities, allowing for sharing and exploiting production resources in the back-end process	Cenamor et al., 2017; Coreynen et al., 2017; Gawer, 2009, 2014
	Production-radical logic	Using advanced manufacturing platforms (e.g., industrial Internet of Things manufacturing platforms) to fundamentally rebuild the back-end manufacturing system and the supply chain foundation	Gawer, 2009, 2014; Jacobides et al., 2018; Nambisan, Lyytinen, Majchrzak, & Song, 2017; Ozalp, Cennamo, & Gawer, 2018
	Transaction-incremental logic	Using platforms (e.g., B2B customer interaction) to enhance the speed and quality of front-end process, offering optimized marketing solutions	Cenamor et al., 2017; Economides & Katsamakas, 2006; Evans & Gawer, 2016; Van Alstyne et al., 2016
	Transaction-radical logic	Using advanced service platforms (e.g., Internet of Things customer platform) to restructure the front-end process, leading to advanced service offerings	De Reuver et al., 2018; Nambisan et al., 2017; Ozalp et al., 2018
Platform development stage	Platform initiating stage	Applying at least one platform leverage logic in platform development, involving front- or back-end strategic partners into the network	Basole & Karla, 2011; Fu, Wang, & Zhao, 2017; Gawer, 2009, 2014; Marcos-Cuevas et al., 2016; Teece, 2017; Thomas et al., 2014; Tiwana et al., 2010
	Platform transitioning stage	Adopting a new platform leverage logic to scale and refine the business, introducing new source of partners, coordinating the network relationships through an institutionalized approach	
	Platform strengthening stage	Deepening the selected platform leverage logic, consolidating the network relationships within the platform, generating co-created and knowledge-intensive outcomes	
Orchestration capability	Targeting	Ability to direct resource deployment and development initiatives in quality management, product design, marketing	Francis & Bessant, 2005; Helfat & Raubitschek, 2018; Paquin & Howard-Grenville, 2013
	Legitimizing and envisioning	Ability to establish commitments, legitimacy, social contracts between participants, and provide actors with visionary ideas	Paquin & Howard-Grenville, 2013; Perks et al., 2017
	Building expertise	Ability to identify, activate, collect, and coordinate knowledge resources	Aarikka-Stenroos & Jaakkola, 2012; Nätti, et al., 2014; Perks et al., 2017
Value co-creation	Co-creation practice	Activity of, and interaction between network actors, where participants co-create value	de Oliveira & Cortimiglia, 2017; Frow et al., 2016; Kohtamäki & Rajala, 2016; Rayna et al., 2015
	Co-creation input	An actor’s contribution to enable value co-creation. This contribution depends upon the actor’s role and position in the value co-creation process	Aarikka-Stenroos & Jaakkola, 2012; Breidbach & Maglio, 2016; de Oliveira & Cortimiglia, 2017; Grönroos, 2008

Appendix B: Data structure, theoretical linkages and representative quotes illustrating second-order themes of orchestration capabilities

First-order categories	***Second-order themes and representative quotes***	***Theoretical linkages***
	Targeting capability	
Evaluate the platform's potential benefits	'The traditional model of low cost and low price is not the way to go for sustainability. The idea of developing a mass customization platform was new to China's apparel industry at that time, but many of our competitors were moving towards it. We evaluated the value co-creation potential of the mass customization business potential and the cost of achieving them. To avoid losing the first-mover advantage race, we decided to develop mass customization business.' (KS5)	Helfat and Raubitschek (2018)consider environmental scanning and sensing as focal capabilities to 'spot new or untapped technologies, unexploited market needs and changes in customer preferences, as well as the threat of innovative entry by new and existing platforms' (p. 1395).
Redefine each platform member's position in the value chain	'To generate additional revenue, we aim to be a digital solution provider and leverage our expertise in digital nylon production by consulting traditional [that is, not yet digitalized] nylon manufacturers.' (HD6) 'Then, we intend to shift our focus from product offerings to integrated solutions in the field of smart spinning that could create more profit, for instance, to offer training courses for traditional spinning SMEs to restructure, transform and upgrade their production foundation towards digitization and ultimately smartization.' (HX3)	Francis and Bessant (2005) identify the ability of re-defining the positioning of the firm or its products, i.e., 'either concerned with what the offerings the organization provides or what identity it pursues' (p. 172), as a critical factor of targeting innovation.
Select partners that can add most value to the entire network	'Then, we intended to expand our reach into the fast-growing 'accessible luxury' segment. Secoo stood out among its e-commerce competitors to be our most suitable collaborator, considering its mature promotion channels. Together, we and Secoo will explore the service innovation model of 'Manufacturer to Brand to Customer'(M2B2C).' (RY4) '[We select partners] that integrate supply chain network and brand assets to strengthen our ability to serve high-end customers.' (RY3)	Paquin and Howard-Grenville (2013) claim that in the growing stage when network orchestrators (i.e., focal firms) seek to replicate high value ties, the focus is shifted to selecting partners and more closely influencing their interactions.

Appendix C: Data structure, theoretical linkages and representative quotes illustrating second-order themes of orchestration capabilities (Cont)

First-order categories	***Second-order themes and representative quotes***	***Theoretical linkages***
	Legitimizing and envisioning capability	
Organize meetings to set and legitimize a common goal	'We hosted a series of meetings where it was able to bring all these people (technology partners) together in the conversation committed to a joint goal and amass critical resources for the digital system development.' (RY2) 'We have organized regular workshops with suppliers of manufacturing equipment (e.g., machines, robots, and assembly lines) in terms of the collaborative development, utilization and expansion of digital technology, which is an essential part of our digital transformation process.' (HX5) 'We led the several rounds of discussion with digital technology experts and global machine suppliers. Finally, we achieved a joint goal of initiating a digital nylon filament manufacturing factory.' (HD4)	Perks et al. (2017) characterize envisioning as a critical capability that entails envisioning the potential value of the platform for its members through e.g., workshops to increase the shared understanding of each party's needs. Additionally, according to Paquin and Howard-Grenville (2013), in the initial stage the focus is on establishing broad legitimacy among partners. At that stage, network orchestrators (i.e., focal firms) seek to 'build something from nothing' (p. 1648).
Develop trust among collaborators	'Making rules beforehand is important to generate trust with our collaborators.' (RY6) 'Although we work closely with our partners to avoid cooperation-related problems, there can be no assurance that we will not encounter cooperation problems in the future. Hence, we set up collaborating rules (e.g., well defined participant requirements and certain cooperation rules) to manage the platform openness and sustain long-term innovations.' (KS1)	Research shows evidences that trust building activities are critical in the process of network orchestration (Paquin & Howard-Grenville, 2013). Similarly, Marcos-Cuevas et al. (2016) stress the importance of trust to bond and inter-connect platform members, allowing them to jointly develop resources.
Manage value conflict	'In the overseas cooperation, many of Ruyi's international brands participated in Secoo's channels, including e-commerce platforms and physical stores. Of course, we encountered barriers, for instance, caused by the culture and business environment differences, and organizational differentiation. Cross-cultural integration is the key to enable successful overseas cooperation. In so doing, we incrementally improved the integration process by first taking a strategic partner role and then working as an operational collaborator, which was proved useful to address problems in conjunction with national and corporate culture differences.' (RY4)	Avoiding value conflicts and aligning the interests of multiple participants are pinpointed as key elements of asset orchestration (Helfat et al., 2009; Teece, 2007). Also, Perks et al. (2017) report a case of a healthcare firm's conflict management failure in platforms, and stress the importance of managing conflicting interests.

Appendix D: Data structure, theoretical linkages and representative quotes illustrating second-order themes of orchestration capabilities (Cont)

First-order categories	*Second-order themes and representative quotes*	*Theoretical linkages*
	Expertise building capability	
Stimulate innovative ideas of platform actors	'Necessary rewards are provided to drive resources for innovation and realize continuous growth.' (HX2) 'Within the community, participators' innovative ideas were stimulated and rewarded, generating a set of high-quality inventions in the differential fiber field.' (HD5)	Orchestration involves innovation stimulation, for instance, through allocating rewards to innovative ideas (Aarikka-Stenroos et al., 2017; Nambisan & Sawney, 2011). Tangible (such as money) or intangible (such as recognition, feedback) rewards stimulate actors to collaborate for innovation. This results in joint value creation (Füller, 2010; Roser et al., 2013).
Introduce innovative services for problem-solving	'On some occasions, our customization business customers who used to place orders via sales managers found difficulties in using the online system. We therefore integrated system designers to create illustrative guidelines and tour videos for users and invited customers who had successfully placed orders in the online system to summarize and share their experience and expertise in the platform.' (RY1)	Aarikka-Stenroos and Jaakkola (2012) consider problem solving capability as an important element triggering value co-creation and service innovation. Nätti et al. (2014) introduce three processes of knowledge absorption that enable service innovation, including knowledge acquisition and assimilation, knowledge transformation and exploitation, and maintaining the balance of learning and knowledge transfer.
Offer professional or knowledge intensive business services	'Material suppliers may lack the necessary knowledge and skills to digitize their product data. Hence, we collaborated with our technology suppliers to digitally support our material suppliers on the transformation of products and inventories. We specifically did so via focused integration of information and communication technologies.' (KS2)	Aarikka-Stenroos and Jaakkola (2012) claim that professional or knowledge intensive business services (e.g., IT services, R&D services, technical consultancy, and legal, financial and management consultancy) can positively stimulate value creation (see also Gummesson, 1978; Løwendahl, 2005).

Appendix E: Data structure, theoretical linkages and representative quotes illustrating second-order themes of co-creation practices

First-order categories	*Second-order themes and representative quotes*	*Theoretical linkages*
	Co-commitment	
Developing a joint goal with platform actors	'After much negotiations, our firm, suppliers and technology partners have jointly made the decision to transform the traditional labor-intensive factory starting from machine-facilitated production and to gradually achieve full digital production. We aim to transform the old facilities bit-by-bit to let them fit the new systems.' (KS4)	Research stresses that value creation requires actors to jointly craft a value proposition, and jointly specify value perspectives (Aarikka-Stenroos & Jaakkola, 2012; Ballantyne & Varey, 2006; Prahalad & Ramaswamy, 2000).
	Co-sharing	
Data storing on a platform level	'Our suppliers uploaded their product data into our material database.' (KS6) 'We stored over two million customers' design and preference data in a customization database center that incorporates much tailoring knowledge and covers 99.9% individual design requirements. Such data is accessible for our material and accessory suppliers.' (KS1)	Data gathering is encouraged to assist manufacturers in achieving additional value creation when interacting with customers and suppliers (Lenka et al., 2017; Mikawa, 2015; Opresnik & Taisch, 2015). An example of such a data gathering activity is collecting customers' behaviors while they design customized products in a digital platform (Xie et al., 2016).
Data sharing with platform actors	'The online platform allows customers to interact with us regardless of location and time limitations, as well as to bring together their feedback, comments and suggestions. Users gain new insights through data sharing. We are trying to share the (customer) data collected from the online platform with our production department, allowing us to translate customer preferences into product features and quality requirements.' (HD3) 'The customization platform is an integrated system where not only supply-chains can be in real-time tuned with our factory, but also retail agents and even end-users can communicate and exchange data within the system.' (KS1) 'The establishment of the ICPS enables data and information collection and exchange at any stage of the process throughout the entire supply chain, generating a real-time virtual duplication of the whole system.' (HX1)	Data sharing and exchange between manufacturers, customers and suppliers are considered as essential processes to increase shared understanding of, and benefits for all network actors (Jaakkola & Hakanen, 2013; Kohtamäki & Partanen, 2016). Research of Xie et al. (2016) reports an example of such a data sharing activity in digital platforms: A clothing firm's customers post feedback on new products through the firm's mobile forum and online platform, allowing the firm to immediately improve its products. This turned out to be highly appreciated by customers.

Appendix F: Data structure, theoretical linkages and representative quotes illustrating second-order themes of co-creation practices (Cont)

First-order categories	*Second-order themes and representative quotes*	*Theoretical linkages*
	Co-analyzing	
Analyzing data in collaboration with platform actors	'With the specific ICPS-related solutions in place, the ICPS control center paved the way together with supply chain partners to analyze the captured real-time information and alert operation risks.' (HX4) 'We collaborate with technology partners in developing data models and analysis methods to translate customer preference data into predictive insights such as demand forecast.' (RY6) 'Our apparel designers and material suppliers work closely together with the information technology suppliers in developing the cloud-based visualization models and analysis methods that enable the autonomous creation of the 3D model of customized products displayed on the platform website.' (KS7) 'The integrated operating system allows our businesses, machine suppliers and technology partners to develop and deploy applications and digital services drawing on real-time asset usage information, such as predicting equipment failure, increasing asset availability, improving product designs or increasing product or plant performances.' (HD1)	Data analysis is one of the most important activities to be able to interpret data collected through a platform, and to transform the data into predictive insights that have operational value for the organization (Lenka et al., 2017). Such a data analysis process can be jointly implemented by manufacturers and technology firms, and can even evolve into a business model innovation (Urbinati et al., 2019).
	Co-problem solving	
Collaboration of platform members to jointly solve problems	'During trial runs, the new system encountered some technique problems. For instance, customers who are used to offline stores contacted us with their problems in using the new system. They hesitated to use it (the new system) due to the difficulties of self-measurement. We noticed customers' concerns and we are currently working with our technology supplier to develop new technologies (e.g., a remote measurement technique), which will further improve the customization system.' (RY1) 'Some of our supply chain partners struggled to recognize the value of our system (ICPS) and hesitated to participate in the network as they considered the sharing of their inventory data through the system as a risk. A negotiation process was undertaken between our business, suppliers and technology partners to specify the problem. As a resolution, we invested in industrial cyber security and jointly developed products, services and software for firewall safety and data security.' (HX2)	Value co-creation occurs through a dyadic problem solving process between the supplier and the customer (Aarikka-Stenroos & Jaakkola, 2012), comprising activities such as identifying the problems, developing and implementing solutions, and analyzing its outcomes (Gummesson, 1978; Lapierre, 1997; Sawhney, 2006; Skarp & Gadde, 2008).

Appendix G: Data structure, theoretical linkages and representative quotes illustrating second-order themes of co-creation practices (Cont)

First-order categories	***Second-order themes and representative quotes***	***Theoretical linkages***
	<u>Co-diagnosis</u>	
Involvement in (iterative) idea development through official meetings, workshops, etc. at a platform level	'The decision-making process was not straight-forward. Several meetings took place to bring together ideas from the digital technology experts.' (HD4) 'We have regular workshops discussing new opportunities and threats in textile manufacturing with our suppliers and technology partners.' (KS4)	Value co-creation involves an interactive idea development process between actors, constantly consulting each other (Aarikka-Stenroos & Jaakkola, 2012; Reypens et al., 2016). Reypens et al. (2016), for example explain (p.44): 'Consultation took place during regular face-to-face or telecom meetings. During the meetings, partners were invited to share and discuss thoughts, ideas, needs, and expectations.'
Receiving customer input through the platform	'We took on board what our customers are saying, most of them demanded customization as a standard; not a luxury.' (KS3) 'We had some customer input, much of it concerned the requirements of enhancing product quality and reducing lead time. We thought the digital manufacturing was a proper solution to address these needs.' (RY4)	Research considers it essential that the customer acts in the role of co-diagnoser of problems to be tackled (Aarikka-Stenroos & Jaakkola, 2012; Ballantyne & Varey, 2006; Marcos-Cuevas et al., 2016; Sampson & Spring, 2012).
	<u>Co-experience</u>	
Interaction with customers to ensure the co-creation of experience	'The e-commerce created channels between customers and us which allowed us to interact with customers and address their problems, providing them a good online shopping experience.' (HD2) 'The platform provided possibilities to interact with any number of customers regardless of their location, and the costs for doing so are negligible. They (customers) typically contact us with their unique problems, and we jointly solve them by constructing a product and service combination that will generate the best outcome for them.' (HX6)	Co-experience activity, which manifests itself in the form of customer interaction with the firm, is recognized as an important element of value co-creation (Bendapudi & Leone, 2003; Frow et al., 2015; Lemke, Clark, & Wilson, 2011; Ranjan & Read, 2016).

Appendix H: Data structure, theoretical linkages and representative quotes illustrating second-order themes of co-creation practices (Cont)

First-order categories	*Second-order themes and representative quotes*	*Theoretical linkages*
	Co-innovation	
Linking internal and external knowledge resources	'In order to facilitate the customization platform, we promoted linkages amongst our material and accessory partners to provide customers multiple design options, e.g., in apparel material and clothing buttons.' (KS7) 'We have broken new boundaries when it comes to creating innovations. Under our talent network program, both internal and external knowledge resources are interlinked.' (RY5)	'Co-innovation is a new innovation paradigm where new ideas and approaches from various internal and external sources are integrated in a platform to generate new organizational and shared values' (Lee et al., 2012, p. 817). Hence, the purposive recombining of internal and external resources is critical to create innovation opportunities (Zwass, 2010).
Jointly developing innovative solutions and manufacturing procedures	'The smart, high-end retail platform will contain a series of fashion and luxury retail innovations, ranging from big data solutions to smart manufacturing, which will enhance customer experiences and reshape the future of retail and e-commerce.' (RY4) 'We introduced a set of advanced machine tools and equipment imported from Italy, Belgium, Switzerland and Germany and kept stable connections with these machine suppliers, as the equipment application and maintenance required constant and mutual collaboration.' (HD1) 'The joint innovation with our technology partners is the backbone of our operational success.' (HX1) 'Together with our technology partners, we jointly designed and developed a digital assembly line for men's suits. We broke down the previous assembly line into over 300 detailed procedures, and each procedure is carried out by the worker facilitated by an electronic screen. Our partners also assisted with sensor technology, such as RFID electronic tags that bring together digital order requirements and physical material in the manufacturing processes.' (KS4)	Shaping creative solutions and smart manufacturing procedures are considered as a result of co-innovation which helps firms to respond to complicated problems or external changes (e.g., in connection with new technology) (Frow et al., 2015; Lee et al., 2012).

Tables

Table 1: Profile of the selected cases

	Huading	**Huaxing**	**KuteSmart**	**Ruyi**
Industry	Nylon filament manufacturing	Yarn manufacturing	Apparel manufacturing	Wool fabric and apparel manufacturing
Number of employees	4,000+	1,000+	2,000+	3,000+
Turnover (2019)	CNY 8.6 billion (USD 1.3 billion)	CNY 973 million (USD 143 million)	CNY 535.1 million (USD 78. 4 million)	CNY 1.2 billion (USD 175.9 million)
Founding year	2002	1987	2007	1972
Business ownership	Listed firm/ Zhejiang	Private firm/ Shandong	Listed firm/ Shandong	Listed firm/ Shandong
Location	Zhejiang	Shandong	Shandong	Shandong
Platform strategy	Building a platform-based Smart Factory producing nylon filament and using a customer interaction platform approach to the B2B market	Establishing platform-based Smart spinning Factory and utilizing a B2B customer interaction platform to reduce the procurement cost and increase profit	Developing a data-driven mass customization platform of men's suits and offering industry 4.0 solutions in a B2B market	Establishing a cloud-based Smart Factory encompassing the whole apparel supply chain, building a customization platform directly connecting clients and factories

Table 2: Profiles of participating managers/divisions

Case	Interviewee	Code	Source
Huading	Managerial representative of manufacturing division	HD1	CV, P
	Managerial representative of marketing and sales division	HD2	CV
	Managerial representative of marketing and sales division	HD3	CV
	Vice president, Chief engineer	HD4	C, I, P
	Vice president, Director of research institute	HD5	I, E
	Managerial representative of manufacturing division	HD6	CV
Huaxing	Managerial representative of intelligent spinning division	HX1	CV, P
	Technological representative of intelligent spinning division	HX2	CV
	CEO	HX3	C, E, I, P
	Vice president, representative of intelligent operation management	HX4	T
	Technological representative of intelligent spinning division	HX5	CV
	Managerial representative of marketing and sales division	HX6	CV, P
KuteSmart	Managerial representative of R&D division	KS1	CV
	Managerial representative of manufacturing division	KS2	CV
	Vice president, Director of KuteSmart engineer college	KS3	C, E, I, P
	Managerial representative of manufacturing division	KS4	CV
	Managerial representative of marketing and sales division	KS5	CV
	Managerial representative of R&D division	KS6	CV, P
	Managerial representative of manufacturing division	KS7	CV
Ruyi	Managerial representative of marketing and sales division	RY1	CV
	Managerial representative of manufacturing division	RY2	CV
	Managerial representative of marketing and sales division	RY3	CV
	Vice president, Chief engineer	RY4	C, E, I, P
	Managerial representative of technology division	RY5	CV, P
	Managerial representative of technology division	RY6	E

Note: C stands for conference presentation with slides on 25 Nov. 2016, CV stands for company visits, interviews and conversations and company reports over a period of 2013-2016, E stands for e-mails in March 2019 and Aug.-Sep. 2020, I stands for regular instant messages over a period of 2016-2020, P stands for panel discussions/workshops in 2016, 2018 and 2020, and T stands for telephone discussions in Sep. 2020.

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Fig. 1: A platform-based leverage framework

Position in the value chain	**New value innovation:** Incremental innovation	**New value innovation:** Radical innovation
Production/Back-end	**(1) Production-incremental logic** Characteristics: Upgrading operational production and logistic performance, reducing supply-oriented costs, strengthening the back-end value additions, improving responsiveness and customization of customer needs. E.g., Logistics and supply chain platform (FIspace)	**(2) Production-radical logic** Characteristics: Reworked back-end production and supply foundations, re-inventing operational management approaches, comprehensively lead time reduction, enabling personalized product and service offerings. E.g., IoT manufacturing platform (AXOOM of TRUMPF)
Transaction/Front-end	**(3) Transaction-incremental logic** Characteristics: Optimizing customer centric processes, incremental front-end value additions, enhancing value co-creation with customers, streamlining front-end interactions. E.g., Online auction platform (Rainworx)	**(4) Transaction-radical logic** Characteristics: Re-conceiving integrated solution packages for new customer value, radical changes of front-end collaborations, generating a quantum leap in value co-creation. E.g., IoT service platform (MindSphere of Siemens)

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Fig. 2: The lead actor's orchestration capabilities

The lead actor's (i.e., manufacturer's) orchestration capabilities

Platform development stages ↓ / **Orchestration capabilities** →	Targeting capability	Legitimizing and envisioning capability	Expertise building capability
Stage 1: Platform initiating	(1) Evaluate the platform's potential benefits	(4) Organize meetings to set and legitimize a common goal	(7) Stimulating innovative ideas of platform actors
Stage 2: Platform transitioning	(2) Redefine each platform member's position in the value chain	(5) Develop trust among collaborators	(8) Introduce innovative services for problem-solving
Stage 3: Platform strengthening	(3) Select partners that can add most value to the entire network	(6) Manage value conflict	(9) Offer professional or knowledge intensive business services

Fig. 3: Platform development process

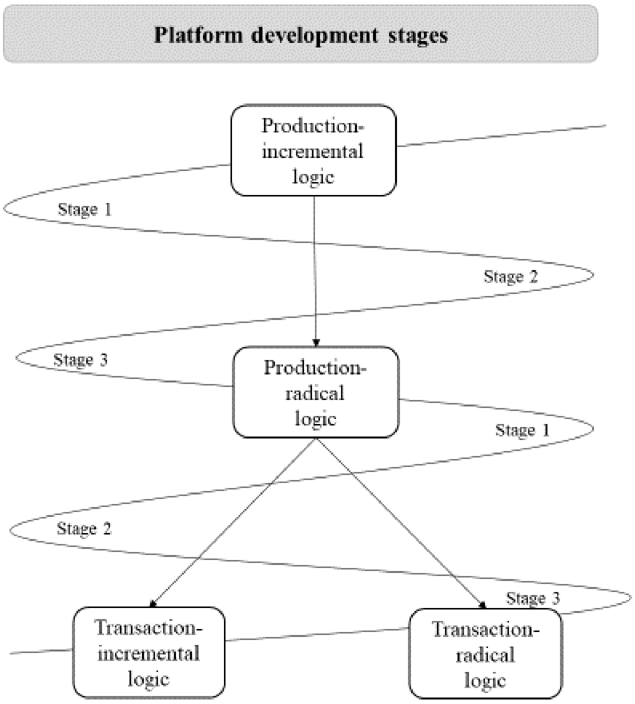

Fig. 4: Platform development and co-creation