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Supply Chain as a Service: Building Supply Chain Capability as a Business Model

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Abstract

With the trends towards servitization and digital innovations in supply chains (SCs), a number of SC leaders have started to commercialize their SC capabilities as services provided to business customers. In order to efficiently organize multiple s

resources and customize the service offerings, some of these leaders have developed a

model (hereafter SCaaS), in which different functions of a SC, are grouped into service modules to enable plug-and-play agility in meeting the varying needs of business customers. Although SCaaS is emerging as an evolution of

Software as a Service, Platform as a Service, and Infrastructure as a Service), supply chain management (SCM) researchers have not systematically studied the SCaaS phenomenon,

Nevertheless, surprisingly little theoretical work has been done on SCaaS. Although the concept was first introduced in 2011 from the cloud and engineering perspective, and has generally been (Leukel *et al*., 2011), follow-up studies are rare. Furthermore, according to recent business practices and some of the SCaaS phenomena we have observed, we found that the cloud and engineering perspective cannot summarize or reflect all the characteristics of SCaaS. The emergence of SCaaS has been accompanied by a ch

paradigms and dominant logic (Resta *et al*., 2017). However, the characteristics of SCaaS in terms of BMI and service-dominant logic (S-D logic)

SC capability into SCaaS. This study contributes to the research on SCM and service innovation by applying S-D logic-based thinking to identify SCaaS, and by revealing the detailed emerging and operational mechanisms (in particular, the value co-creation activities among multiple interaction processes) underpinning SCaaS.

The remainder of this paper proceeds as follows. Section 2 includes the literature review. In Section 3, the in-depth case study methodology is presented. In Sections 4, research findings are described. In Sections 5 and 6, propositions are developed and findings and implications are discussed.

2. Theoretical background and research questions

2.1 The positioning of SCaaS

PSS is defined as a transformed model of traditional product-based business towards increased strategic and operational service emphasis (Resta *et al.*, 2017; Brax and Visintin, 2017). It provides service portfolio of

subsystems, modules and components of hardware, soft

Visintin, 2017, p.22), which are jointly produced and operated with loosely coupled third parties. Therefore, first, compared to traditional manufacturing SCs which mainly include functions of R&D, procurement, production, distribution, consumption and disposal, and follow a linear take, make and dispose process (Yang *et al.*, 2018), the SC of PSS incorporates more functions, such as richer customer services, installed software operation, and recycling, covering the entire life cycle of a product-service solution (Holmström *et al.*, 2010), by an end-to-end close-looped manner (Yang *et al.*, 2018). As pointed out by

2.3 Value co-creation in SCaaS

S-

S-D logic provides a generalized and macro view of the interactions among loosely coupled actors to co-create value through operand and operant resources (Lusch, 2011; Vargo and Akaka 2012). However, there is still a lack of knowledge of how the mechanism operates, how the detailed value co-creation activities take place among multiple interaction processes, and how to achieve the systemic and synergistic effects of the value co-creation network (Lusch *et al.*, 2010; Lusch, 2011). Although the engineering design perspective focuses on the detailed day-to-day operation, this view has not expanded its scope of application from strongly linked SC netwroks to weakly linked SC networks.

In a recent study, Jacobides *et al*. (2018) proposed two types of value co-creation modes in service ecosystems: one with unique complementarities, defined as a mode in

-specialization); and one

-creation

mechanism in the SCaaS in terms of the conditions under which or in what ways external participants in the SCaaS can offer unique or/and supermodular complementarities with the focal firms. To some extent, a SCaaS is an open service system that helps the PSS provider to motivate and manage the third-party

activities are organized to serve the business customers?

RQ3: What is the detailed service operation process of SCaaS for satisfying a specific customer demand?

3. Methodology

3.1 Case study design

Since we are examining a relatively new phenomenon with limited explanatory works done (Suddaby, 2006; Gligor and Autry, 2012), a case study method is appropriate to derive theory from field data (Eisenhardt, 1989; Strauss and Corbin, 1990; Yin, 2009). This approach provides rich insights by observing actual practices in context (Weick, 2007) and allows empirical development of testable theories (Closs *et al*., 2008; Pagell and Wu, 2009). Further, the case study method can qualitatively capture the features of the emergence and evolution path of SCaaS over an extended time horizon

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We chose mainland China as the research setting as China has evolved into a world manufacturing center and consequently its SCs cover a wide range of industries, with a great many of industry clusters where large numbers of factories, brands, distributors and supportive service providers co-exist.

international standards-developing bodies, have chosen Haier to lead the development of international standards for the model of mass customization and industrial Internet platforms (Report of 2018Q3, Haier smart home, stock code: 600690[2]).

3.3 Data collection

This study combined multiple data-collection methods. The primary method was in-depth interviews with key members the sample firm over almost six years (2014 2019). These semi-structured interviews followed a protocol (see Appendix). The interviewees were asked about SC strategies, SCIs, BMIs, and servitization. Their experiences were explored from a longitudinal perspective; they were allowed a great deal of freedom to express their views and raise new issues (Yin, 2009) to explore the naturally occurring data (Silverman, 2006). Researchers of this study were careful not prompt the interviewees. Interviewees were selected from different business units and organizational levels in order to increase the reliability and internal validity of the data generated in the case study (Yin, 2009). To explore the role of COSMO, the research team also conducted three pairs of dyadic interviews with members from both the Haier COSMO SC service project team side and from the empowered business customers side. Table 2 provides a summary of the interview data.

---------------- Insert Table 2 about here ----------------

Additional data were collected by participating in and observing joint or

[2] http://www.haier.net/en/investor_relations/haier/

service modularity, and SC service ecosystems.

The specific coding procedure was undertaken in three steps. First, we started with

(Gioia *et al*., 2013). One author conducted multiple rounds of comparison and combination of similar or different themes that emerged; these themes were double-checked individually by other authors to ensure their consistency. Where controversial issues arose, the coding process returned to the initial coding. Through this step, we derived a set of first-order concepts.

In the second step, we explored theoretical interpretations of the first-order concepts. This involved an iterative process of comparison and matching between concepts and the extant literature on SCIs, service modularity, and BMIs. We tended to use concepts identified in previous research to summarize the second-order themes, as suggested by Pan *et al*. (2008) and Li *et al*. (2018). We follow Zott and Amit (2010) and use the three design elements content (the selection of activities and value propositions), structure (how the activities are linked), and governance (who performs the activities) to identify BMIs in the data. The classifications of SCI are multiple and varied in the literature. However, most of the classifications are based on the precondition that considering SCI as complementary or supporting activities to a final product/service or a business model. For instance, Bello *et al*. (2004) and Wong and Ngai (2019) divided SCI as logistics-oriented, marketing-oriented and technological development-oriented innovation activities. However, these classifications cannot summarize the innovation characteristics in the

the interactive implementation of SCIs and BMIs at each step and between each step.

Step 1: transforming capabilities in each SC function into commercialized, single-function SC solutions. This step, during 2014-2016, can be considered as a pre-COSMO period, when Haier attempted to provide B2B SC solutions but these were still based on its original SC system. In step 1, Haier mainly provided single-function SC solutions and ran separate platforms for each SC function.

Step 2: transforming capabilities of SC integration into commercialized, cross-function

modular production) and decomposed the old, rigid SC six weeks, and who is responsible for it. With this system, orders were placed weekly, the supply was driven by demand, and the average stock turnover was reduced to 5-7 days. Compared with the traditional inventory in the home appliance industry, typically up to several months, Haier had almost reached zero inventory

SCI stage1-2: Developing separate platforms for each single SC function to manage resources and jointly provide PSS

As the Internet began to grow in China, the end users of its home appliance products, began to play critical roles in the market. Therefore, like other manufacturing firms transforming into providing services in addition to their products (Rajala *et al*. 2019), Haier started to provide PSS, including individualized order creation, product design interaction, traceability in manufacturing and logistics, the last-mile delivery and installation service at a particular time slot ordered by the customer, and a continuous customer service, via the Internet, on the use of the products.

In order to support such PSS, the mass customization SC capability needed to be enhanced so that it could more exactly meet individual needs. This was done by flexible reconfiguration of end-to-end SC resources. Haier thereby built an advanced mass customization SC capability, a so- configuration-to-or (CTO) capability, through which individualized orders could be decomposed into sub-processes to be fulfilled at different SC functions (procurement, production, logistics, etc.). In addition, information was shared among these SC functions so that the final PSS could be jointly produced.

In developing the CTO capability, Haier found that the traditional linear structure of its SC (with the disadvantage of lacking direct communication between companies logic, Haier also changed the SC function of procurement to a sourcing platform so that external providers of components can freely compete; this obviates any potential problems with corruption in the procurement process.

Through these separate platforms for each single SC function, Haier has attracted various third-party resources in different SC functions for better PSS provision.

4.2 Stage 2. Transforming SC capability into SC solutions for external firms

Step 1: Transforming capabilities in each SC function into commercialized single-function SC solutions (2014-2016)

BMI-step1-1 (value proposition): Developing a new group of customers (external firms) and providing them with single-function SC solutions.

With the development of these separate platforms for each single SC function, leaders of these platforms realized that, due to the single-source demand (all customer

Through carefully defining the qualification, business customers requirements and feedbacks, and SC solution offering process, standardized service modules were gradually identified and developed prior to the definition of cu requirements. The integration work is mainly undertaken by Haier. These modules can also be provided separately or combined with the existing solution. Haier remains in charge of monitoring the whole process, deciding what is to be implemented by Haier and what is to be implemented by the third parties.

Through these processes, increasingly specialized single-function SC solutions were identified by composing a series of service modules according to different scenarios. For instance, as shown in Figure 3, four specialized solutions have been derived from the initial basic procurement solution: mold development solution, group purchasing solution, procurement process optimization, and supplier relationship management.

It is worth mentioning that the elaboration of the specialized service modules and solutions within each SC function also promotes the original PSS business.

------------------------------------Insert Figure 3 about here-------------------------

Interaction between SCI and BMI

prove to be a successful design, and we will pre-sell through our various e-commerce channels and drive the supply and production. (A top executive of Haier)

Haier also developed a series of cross-function modules, especially for the cross-function SC integration solutions (different from the ones for its own PSS), such as underlying technical resources (e.g., cloud server, algorithm libraries, and database), cross-function management information systems (e.g., ERP, OMS, MES, WMS), process integration and real-time process visibility. These cross-function modules help Haier to coordinate various single-function SC solutions.

-----------------------------------Insert Fig 4 about here-------------------------

SCI-step2-2: Developing new SC functions and specializing cross-function SC solutions

Since 2012, Haier has been making efforts to speed up product development by

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which focus on developing a flexible mass customization process by using intelligent technologies. In 2016, Haier set up an intelligent manufacturing research institute to study how to commercialize its intelligent manufacturing solutions to help external firm functions into themes, to offer diversified SC integration solution packages. These themes included customer-to-manufacturer (C2M) solution, start-up incubation solution, and supply chain financing (SCF) solution. Thus, Haier decomposed the whole SC through the identification of new, specialized SC functions and the expansion of SC solutions, sometimes in different combinations (see Figure 4).

---------------- insert Figure 4 about here ----------------

BMI-step2-1 (value proposition): Providing external firms (in different SC roles and in different industries) project-based customized SC solutions

independent SC system, COSMO

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what kind of customers are selected by the COSMO. Compared with the governance mechanism in step 1, which focused my partners and I serve you, or essentially a service transaction relationship, in step 2 the governance mechanism for business customers was we interact for service co-production.

Compared with the single-function SC solutions in step 1, the specific themes of the cross-function SC solutions are more complex, non-standardized, and need more interactions with customers. In order to achieve its own customized solutions as well as those of third-parties, Haier requires interaction with customers for every SC function.

also puts demands on customers, in that it requires them to be able to lead and contribute knowledge to the solution, that is, to engage in solution co-development and achieve a co-specialization by interaction with solution providers. Haier therefore chooses leading firms or firms with years of industry experience as business customers in various industries. For instance, the first customer in the clothing industry is a top-

transactions based on buying and selling, which can be found in the traditional economic era, but they are less important in the Internet era. Without the added value generated by interaction, as long as there is no platform for value interaction, it should not exist. Senior manager of COSMO, quoting the words of the chairman of Haier group)

Another interviewee emphasized that:

COSMO is a multilateral value co-creation platform and an ecological closed loop. All resources, capabilities, and technologies can be released, but only if the external enterprise can create value at any point of the loop can it exist in the platform. of the Haier group)

---------------- insert Table 4 about here ----------------

Interaction between SCI and BMI in step 2

In step 2, the interaction between SCIs and BMIs was mainly manifested as SCIs supporting BMIs. Two SCIs, (1) the methodology development for basic cross-function SC integration solution, and (2) the expansion of new SC functions and specialization of integrated solutions, jointly prm(prm(d(en-GB)>> BDC :8>> BDC :8>> BDC :8>> BDC :8>>)]TJETI providing solutions to different industries. Therefore, Haier started to change the project-based customized SC solutions to modular-based, mass customized SCaaS in terms of rebuilding the service architecture, interface, and processes, through SCIs and BMIs.

SCI-step3-1: Building a modular SC resource pool

Based on the module development in specializing single-function SC solutions in step 1, specializing cross-function SC solutions in step 2, and the project-based customized SC solution provision in step 3, Haier developed a modular resource pool, which structurally accommodates the broadest coverage and complexity of diverse SC service modules. Thus, Haier can provide a flexible and diverse portfolio of modules for external firms in different industries.

According to the case data, the resource pool has three characteristics:

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can deal with simple and common requirements, in the form of SaaS self-service. In this situation, the customer is responsible for assembling the modules into a solution. Depending on the complexity level of the service requirement, the customer will partly interact with the industry platform for some common modules and partly interact with the project team for some customized modules.

Interfaces of these different industry platforms connect to the same pool of resources; in other words, these industry platforms are the of the parent platform

Based on the modular resource pool, upgraded service architecture, interface, and value proposition, COSMO summarized a standard

the data analysis, the process can be summarized as the following four steps:

(1) ***Identification and decomposition of customer demand.*** T

(4) ***Feedback and module update.*** This involves customer feedback, and the formation of common modules from the customized modules. If the customer feedback has a common theme, it likely that more customized modules can be formed are into common ones, increasing service speed and freeing up more effort to make new customized modules, resulting in a positive feedback loop.

BMI-step3-3 (governance mechanism): Maximizing the interests of all stakeholders by achieving supermodular complementarity

The case data shows that in step 3, the change of value proposition is reflected in the deepening of value co-creation. That is, there is a shift in emphasis from co-production (or co-specialization) in step 2 .

In step 2, the value created by the interaction was still limited to a role within a solution, benefiting only those parties involved in the interaction. (In other words, the value of the interaction was for example within the same industry.) At that point there were not the tools and mechanisms to enable value co-creation to expand to its fullest potential.

However, in step 3, through the establishment of the modular resource pool and the service architecture of front-back stage decoupling, the value created by the interaction in the development of some solutions can be better located within the common modules, or components of customized modules, and spread to other (such as cross-industry) customers' applications. This breaks down the barrier of value utility, so that the value of co-creation can have greater utility, and value co-creators also get greater benefits.

side to achieve supermodular complementarity can the interests of all stakeholders be maximized. The SCaaS can be realized only by maximizing the interests of all parties. The other condition is that the architecture of a SC service system must achieve front-back stage decoupling and two types of interfaces to support the mass customized SC solutions. Unlike a typical *resulting in the final SCaaS.*

P1b. A SCaaS can be identified when: 1) the supermodular complementarity with both external resource suppliers and customers is appeared; and 2) a front-back stage decoupling architecture with two types of customer interfaces is developed.

The case findings also reveal the roles and key activities for each role that the SCaaS can help to manage. These findings also indicate how SCaaS can operate and what resources and capabilities should be used in providing the mass customized SC solutions.

Therefore, we propose that:

P2. A SCaaS offers a matrix of SC service modules which cover all major functions of a SC, and are co-created by all major SC roles like suppliers, manufacturers, brand companies, distributors, logistics providers, designers and R&D professionals. Business customers can freely configure these modules to satisfy their varying needs. As to the details, in specific:

P2a: A service architecture featured by a decoupled front-back end is built to manage the key activities of all major SC roles.

(1) The back end is a modular resource pool covering a variety of SC resources (from within-function to cross-functions). The resource pool incorporates three types of modules (cross-industry common modules, within-industry common modules and

(2) The front end is a customer interface which allows two types of interaction. One is

for the direct, offline interactions between a cross-organizational project team and a business customer. The other is the human-computer interfaces in each industry sub-platforms. Depending on the complexity level of service requirements, a business customer may resort to both types of interaction in one solution. That is, to interact with the project team for using customized modules, and to use common modules in a simpler, SaaS-style way.

P2b: The business customer in a SCaaS can go beyond benefiting its own supply chain. That means it can co-create value with the SCaaS leader for meeting the demands of other customers. In this way, the business customer will become a new third-party resource supplier of SCaaS.

Besides, the findings of the case analysis also reveal the detailed service process of a SCaaS. We propose that,

P3: The service process of a SCaaS contains the following four steps:

Step 1: Processing with customer demands: To analyse the customer demand, and identify which parts of demand should be addressed by the project team, and which parts of demand can be satisfied via the human-computer interfaces.

Step 2: Modular resources coordination: Determining which parts are to be taken from common modules and which parts need to be developed into customized modules. For developing customized modules, it is important to identify the potential supplier the platform itself, a core partner, or a peripheral partner in a loosely coupled relationship.

Step 3: SC solution development and delivery: Configuring and c

Mentzer, J.T., DeWitt, W., Keebler, J.S., Soonhoong, M

Table 2

Table 4. Co-production of Haier and its business customer in step 2

Customers	SC solution services from Haier		Co-produced value
Compaksrv (the mobile homes industry)	Customer service solution	Extend the after sales service, connect customers with vehicles, camps, and travel services together	· Order volume increased 62%
	Procurement solution	Gather the needs of other mobile homes enterprises, conduct intensive procurement for 8 kinds of bulk materials, and concentrate the suppliers of mobile homes tent, furniture and vehicle frame in a special industrial park.	· The procurement cost of some materials was reduced by 12%, and the comprehensive procurement cost was reduced by 7.3%
	Intelligent Manufacturing solution	Help Compaksrv to achieve process optimization, production cycle balancing, and lean production management.	· The product delivery cycle was shortened from 35 days to 20 days · The pass rate of one-time delivery has been increased from 95% to 97%
	Logistics solution	Developed a cross-border logistics system for the mobile homes industry, through which decentralized logistics needs of different mobile homes enterprises are brought together intensively.	· Reduction of logistics cost
	Interactive design & C2M	Help Compaksrv directly connect with users, understand user needs, and introduce module providers to participate in product design to promote the formation of mass customization needs.	· Achieved better quality control by reducing ten thousand components to one thousand modules · Customer satisfaction was enhanced.
	SCF	Haier provides SCF services to Compaksrv by controlling its SC.	· Reduction of financing costs
Unified ceramic (the ceramics industry)	Intelligent Manufacturing solution	Help Unified ceramic upgrade production line and reengineer the operation flow through SC digitalization.	· Production costs fell by 7.5% 12 RMB/piece->11.1RBM/piece · Product quality improved 4.5% 95% -> 99.5% · Unit price of products increased by 17% 13.3 RMB/piece ->15.6 RMB/piece
	R&D	Under the pressure of environmental protection and energy saving, guide Unified ceramic to shift the R&D focus to the industrial ceramic tiles.	· Sales rose 30% against a 23% drop in industry sales · Corporate profits also rose 32 %
	Customer service solution	Connect ceramic tile production with logistics service, installation service, decoration service, and related supervision service to expand the market of ceramic tile after service.	· Customer satisfaction was enhanced.
Aspop Jeans (the clothing industry)	Intelligent Manufacturing solution/ C2M	Help Aspop to improve flexible production capacity, to realize the rapid return	

Appendix: Interview protocol

Table A1 for the sample firm

The list of meta-questions addressed in the face-to-face interviews with managers focuses on the evolution of SCIs and BMIs in the dynamic development of the sample firm.	
1.Introduction	• Purpose of the interview • Outline of the intended coverage of the interview • Description of the anonymity rule in the interview • General interview guidelines • Structure of the interview • Definitions of SCI/BMI and development of stages

Figure1. Data structure

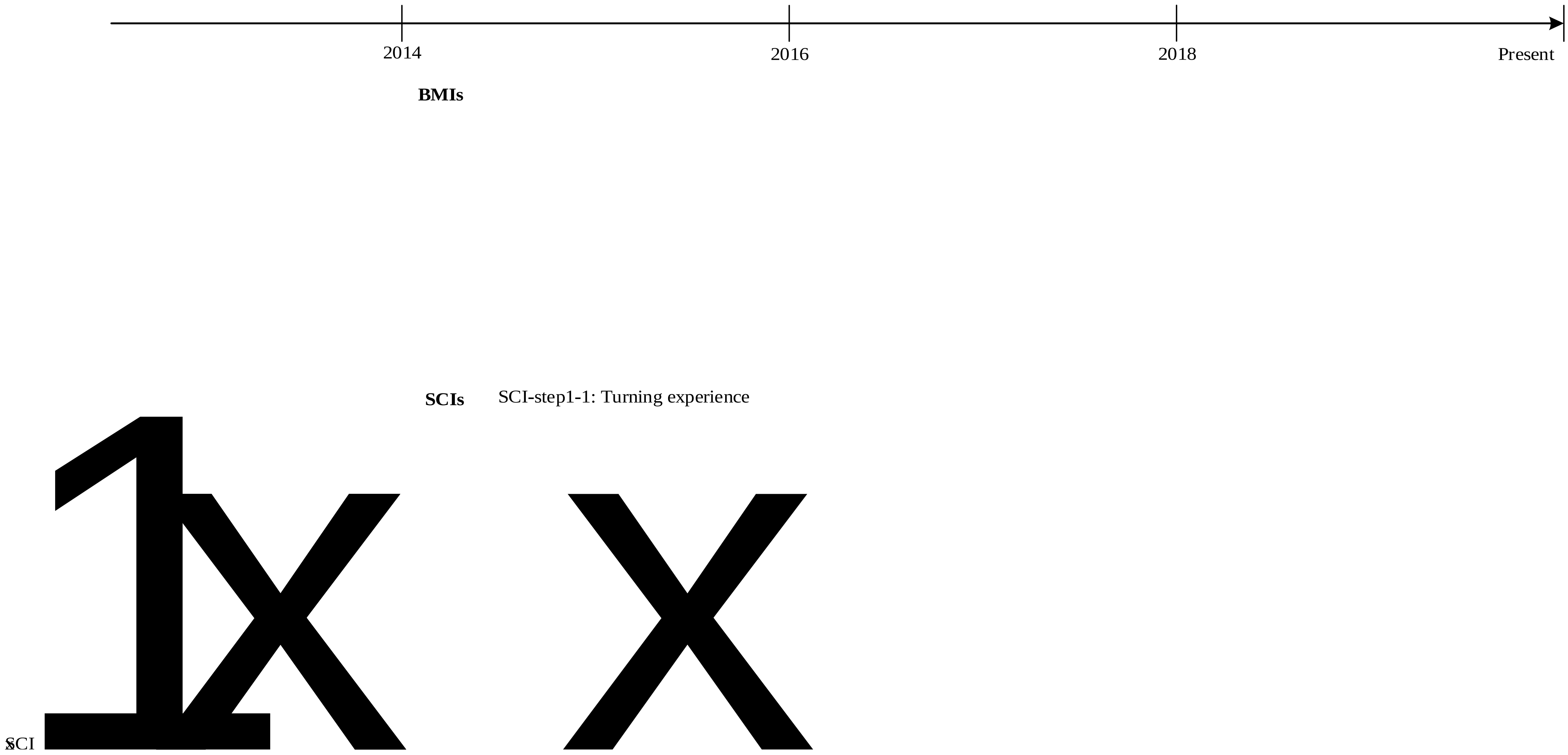
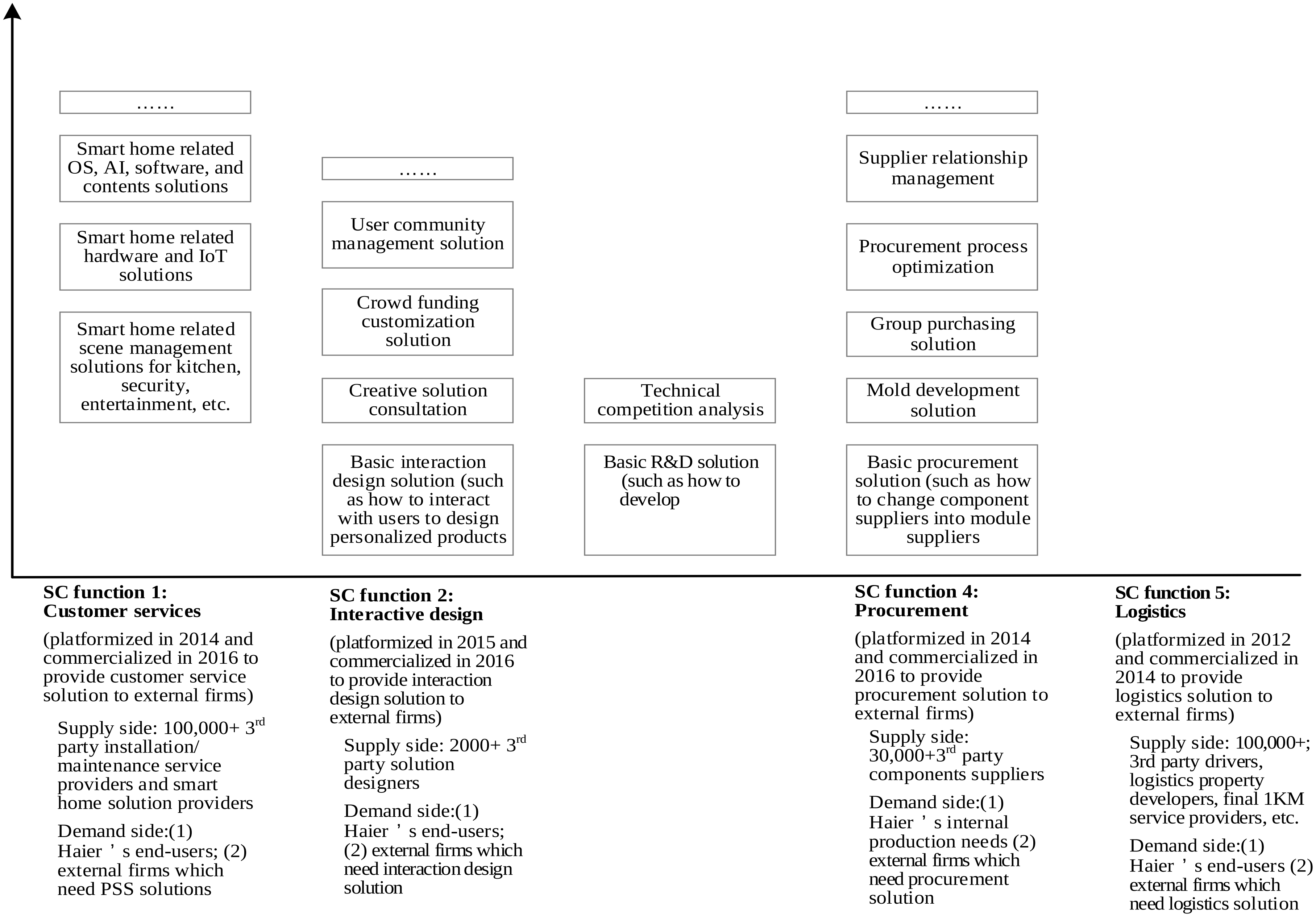


Figure 2. Interaction between SCI and BMI during the two stages and three steps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Smart home related OS, AI, software, and contents solutions
Smart home related hardware and IoT solutions
Smart home related scene management solutions for kitchen, security, entertainment, etc.
……
User community management solution
Crowd funding customization solution
Creative solution consultation
Basic interaction design solution (such as how to interact with users to design personalized products
Technical competition analysis
Basic R&D solution (such as how to develop
……
Supplier relationship management
Procurement process optimization
Group purchasing solution
Mold development solution
Basic procurement solution (such as how to change component suppliers into module suppliers
SC function 1: Customer services
(platformized in 2014 and commercialized in 2016 to provide customer service solution to external firms)
Supply side: 100,000+ 3rd party installation/ maintenance service providers and smart home solution providers
Demand side:(1) Haier ' s end-users; (2) external firms which need PSS solutions
SC function 2: Interactive design
(platformized in 2015 and commercialized in 2016 to provide interaction design solution to external firms)
Supply side: 2000+ 3rd party solution designers
Demand side:(1) Haier ' s end-users; (2) external firms which need interaction design solution
SC function 4: Procurement
(platformized in 2014 and commercialized in 2016 to provide procurement solution to external firms)
Supply side: 30,000+3rd party components suppliers
Demand side:(1) Haier ' s internal production needs (2) external firms which need procurement solution
SC function 5: Logistics
(platformized in 2012 and commercialized in 2014 to provide logistics solution to external firms)
Supply side: 100,000+; 3rd party drivers, logistics property developers, final 1KM service providers, etc.
Demand side:(1) Haier ' s end-users (2) external firms which need logistics solution

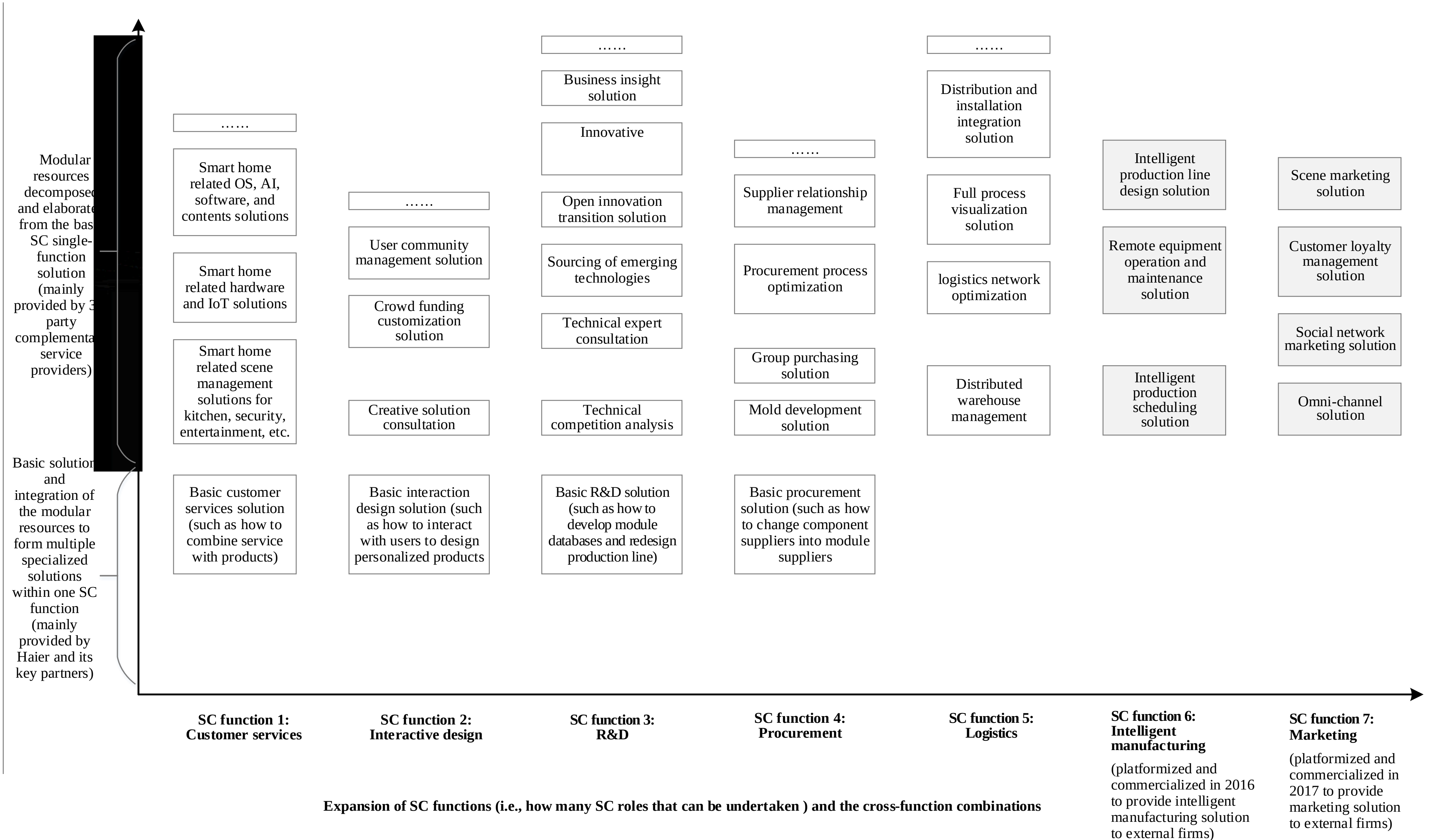

Figure 4. Developing specialized new SC functions and integrated solutions across SC functions in Step 2

Depending on the complexity level of service requirements, a business customer may resort to both types of interaction in one solution. That is, to interact with the project team for using customized modules, and to use common modules in a simpler, SaaS-style way.

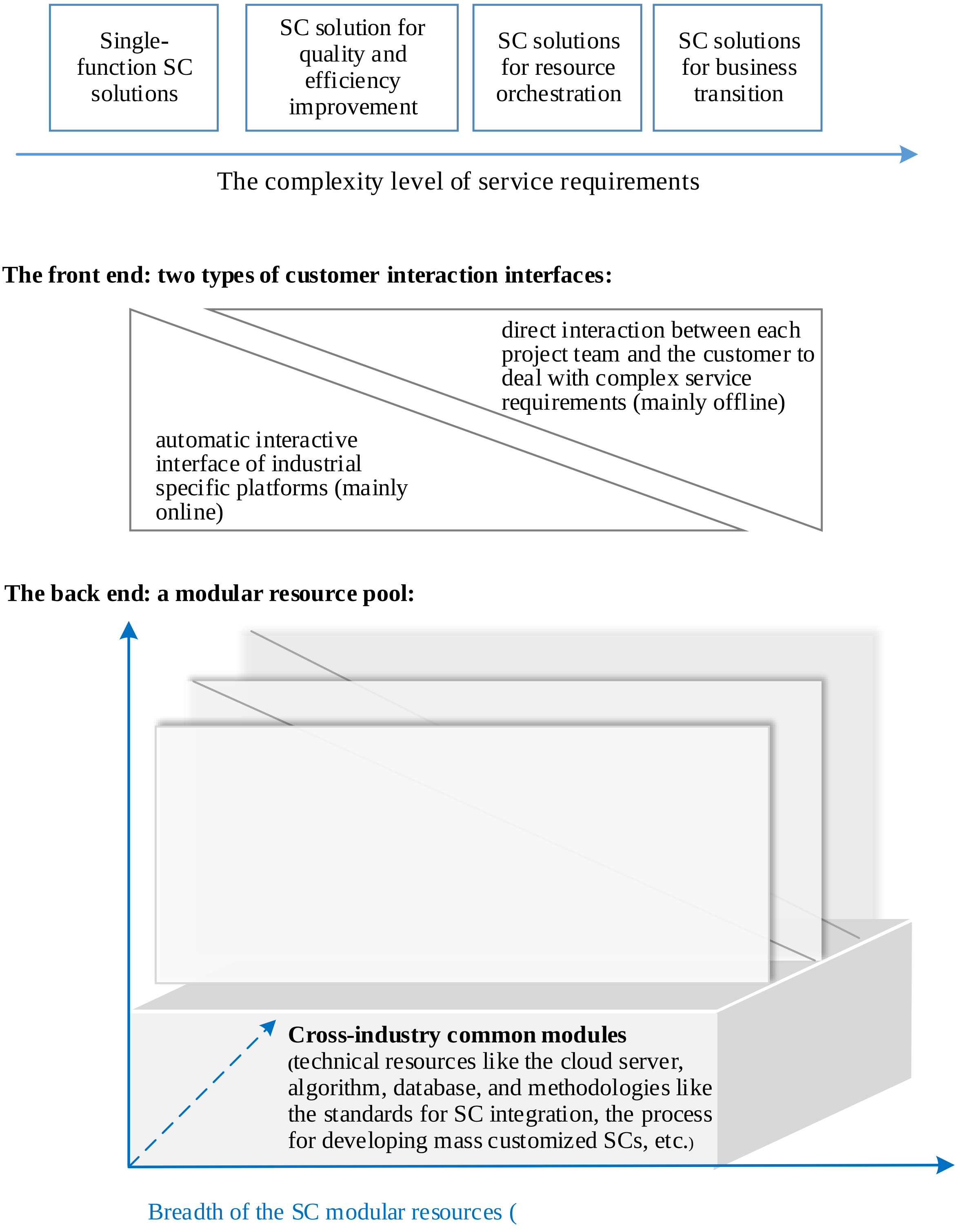

Figure 5. SCaaS in Stage 3