

# Navigating Digital Innovation – The Complementary Effect of Organizational and Knowledge Recombination

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**Abstract.** This paper reports findings from an exploratory series of case studies undertaken to better understand the impacts of digitization on organizational and knowledge recombination. While ‘digitalized firms’ are expected to frequently update their knowledge (e.g., big data analyses, ‘smarter’ products) and organizational structures (e.g., agile team structures, open innovation approaches), we know little about the interrelations between recombining knowledge and organizational capabilities. Therefore, we collected data from 19 interviewees in 8 different firms from four industries. Our study integrates theoretical notions from the literature on organizational and knowledge recombination theory and categorizes the emerging shifts arising from digitization. Our results suggest that the identified changes in the digital age manifest as increased proximity to the customer (by fully digitizing the customer interface and digital co-creation) and celerity to the markets (cross-organizational teams, and collaborations with start-ups and competitors) affecting the whole organization.

**Keywords:** digital innovation, case studies, recombination, celerity, proximity.

## 1 Introduction

Ever since the seminal writings of Schumpeter, recombination is at the heart of innovation practices [1]. Schumpeter noted that innovation “consists to a substantial extent of a recombination of conceptual and physical materials that were previously in existence” [2, p. 88]. Accordingly, recent research commentaries on innovation in the digital age (e.g. [3]) also portray digital innovation in terms of recombination. Yoo et al. describe digital innovation as “the carrying out of new combinations of digital and physical components to produce novel products” [4, p. 725].

It is widely acknowledged that for a firm to ‘go digital’ will involve updating knowledge (e.g., big data analyses, ‘smarter’ products) and altering structures (e.g., agile team structures, open innovation approaches). Still, there is a need to better

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understand *what* components need to be recombined and to what extent there are interrelations between recombining knowledge and organizational capabilities. The innovation literature often scrutinizes the ability of firms to recombine resources in general [1], knowledge resources [5], IT resources with other resources [6, 7], or digital and physical components [8]. For example, Carnabuci and Operti [9] investigate recombinant capabilities of firms that allow them to recombine existing technologies for innovations.

However, the extant literature in the field of recombination and innovation mainly focuses on knowledge and component recombination, neglecting potential complementarities to the organizational perspective. Although Galunic and Eisenhardt [10] mention that delineations of competency areas may affect resource combinations, and Karim and Kaul [11] examine how the recombination of business units within a firm affects firm innovation, we know little about the interplay of recombining knowledge and organizational elements. We hence aim at identifying shifts in digitizing firms and disclosing how those firms navigate their knowledge and organizational capabilities from traditional waters into a digital environment by knowledge and organizational recombination. We are particularly interested in how this recombination affects innovation success, i.e. the commercialization of new knowledge in form of new products or services [12]. Following the recent call of Henfridsson et al. [13] that “it would, therefore, be useful to examine [...] the relationship between organizational design and product design” [p. 39] our research question is: *How does the interplay of organizational and knowledge recombination relate to innovation success within a digital context?*

Methodologically, we conducted exploratory case studies with 19 interviews in 8 organizations to derive categories for organizational and knowledge recombination and identify complementarities among them. Theoretically, we build on Carnabuci and Operti’s [9] distinction of recombinant reuse (recombination of familiar knowledge) and recombinant creation (recombination of unfamiliar knowledge). Concerning organizational recombination, we build on Karim and Kaul [11] but go beyond their notion of structural recombination by also considering inter-organizational relationships as identified by Mintzberg [14]. Together, this allows us to incorporate the largely neglected complementarities between the knowledge and organizational based perspectives in innovation research that, as the results show, shape the modern digital firm.

The next sections review the literature on recombination theory from a knowledge and organizational perspective, introduce and analyze the case studies and then discuss the main findings, their limitations, and implications for future research.

## **2 Recombination - A Theoretical Background**

### **2.1 Recombinant Reuse and Recombinant Creation**

Carnabuci and Operti [9] provide a granular perspective on recombination by distinguishing between recombinant creation and recombinant reuse. *Recombinant creation* is the “ability to envision and create combinations using technologies that [...]

have never [been] combined before” [6, p. 1592]. An example is the “fitness tracking” services enabled by connecting Nike’s running shoes and Apple’s computing products, two technologies that the firms had never previously integrated [15].

*Recombinant reuse* is the “ability to refine and reuse systematically known technological combinations to solve new problems and develop new applications” [6, p. 1592]. Henderson and Clark [16] call this architectural innovation as the recombination is used to replace existing components because of an inferior cost structure and/or performance issues. An example of recombinant reuse is Apple realizing shortly after the invention of the iPhone that combining its operating system and its mechanical components, e.g. its camera, offered opportunities to develop a wide range of novel applications [17]. Thus, they progressively deepened their understanding of this technological combination and generated a string of advanced technological devices, including gyroscopes and accelerometers.

## 2.2 Organizational and Knowledge Recombination

Henri Poincaré pointed out that new knowledge stems from existing knowledge, and is (or builds on) the combination of existing knowledge [18]. Still, controversies remain on where the knowledge elements should be selected from. Some researchers (e.g. [19]) stress that industries are clearly divided and that various technical fields are strongly separate so that knowledge inside a field can hardly be understood by outsiders. Therefore, new knowledge is often built on existing knowledge elements within such fields [20]. In contrast, Hargadon [21] suggests that technical convergence through combining knowledge from different fields can create huge market returns. The idea is that combining more diverse knowledge sources challenges actors and existing concepts and thus stimulates innovation [22]. This notion is elaborated for the digital era by Lyytinen et al. [23] and Nambisan [3]. They emphasize that convergence and recombination of knowledge are particularly advantageous for digital innovations as the malleability of such technology [13] allows for greater flexibility in the alteration of digital products from a knowledge perspective.

Nevertheless, the recombination of knowledge from various fields may be obstructed by inter- and intra-organizational boundaries between firms, business units, or even departments [24]. Hence, Karim and Kaul [11] examine the effect of the recombination of organizational structural elements (“structural recombination”) on innovation from an organizational perspective. They find that structural recombination complements knowledge recombination by dissolving unit boundaries, thereby enabling intra-organizational knowledge synergies. Similarly, previous work has shown that the transfer and sharing of knowledge across internal boundaries (i.e. amongst different units within an organization) is an important source of firm innovation and competitive advantage [1]. The essence of this strand of research is that a firm that wants to realize intra-organizational knowledge synergies beyond the explicit transfer of knowledge between units should alter its structure, dissolve internal boundaries and reshuffle activities among units [25]. Karim and Kaul refer to these changes as structural recombination, defined as “changes in business units as their resources and market activities are reorganized by merging units together, generally through the absorption

of one unit into another unit or the formation of a new business unit by combining existing units” [19, p. 441]. This highlights that structural recombination is a subset of the larger set of organizational reconfigurations that have been studied in the prior literature and that include the addition and deletion of units as well as their recombination [26].

### 3 Methodology

We followed an exploratory case study approach to understand how the interplay of organizational and knowledge recombination is related to innovation success. We chose case studies as they are particularly suitable to answer “how” and “why” research questions and when the relationship between context and phenomenon is unknown [27][28]. For data collection, we conducted 19 interviews following semi-structured guidelines with open-ended questions to assure openness for every possible research direction. We contacted senior managers responsible for strategy, R&D, innovation, IT, or marketing/sales from various firms that may be expected to be key informants in the areas of interest. Usually, we collected data in a firm if three different senior managers agreed to participate. In case that one manager was able to cover the entire area of interest because of his background, we rested with one interviewee. The organizations were not limited to any industry in order to learn about differences in several sectors. Table 1 provides an overview of the cases, industries, and interviewee position:

**Table 1.** Case, Industry, ID, Interviewee Position and Length

Case	Industry	ID	Interviewee Position	Length [min]
A	Manufacturing	IP01	Innovation Manager	59
B	Financial Services	IP02	Innovation Manager	68
		IP03	Head of Product Management	66
		IP04	Chief Technical Officer	57
		IP05	Head of Business Development	72
C	Publishing	IP06	Deputy General Manager	70
		IP07	Chief Technical Officer	66
		IP08	Marketing Manager	72
D	Financial Services	IP09	Head of IT & Organization	83
		IP10	Chief Executive Officer	45
		IP11	Product Group Manager	91
E	Manufacturing	IP12	Head of Automation and Controls	121
		IP13	Director of Technology Management	54
		IP14	Chief Digital Officer	57
F	Financial Services	IP14	Chief Digital Officer	57
G	Financial Services	IP15	Chief Executive Officer	65
H	Manufacturing	IP16	Chief Digital Marketing Management	53
		IP17	Chief Financial Officer	46
		IP18	Chief Marketing Manager	53
		IP19	Chief Executive Officer	45

We carried out the interviews mostly onsite involving two or three of the authors as interviewers. Our interview guideline is designed as follows: First, we asked about any recent digital initiative. We particularly probed into specificities of the company's innovation process, critical success factors, involved units, and the corresponding team structure. Furthermore, we gathered information on the wider organizational structure of the company, its governance, and leadership structure. The interviews took place from November 2015 to July 2016. All interviews were transcribed, and project documentations, related reports, company's financial statements, off-record notes, and observations were used to augment and triangulate the interview data. Data analysis proceeded through reiterations between looking for meanings in the data, writing descriptions, coding and revisiting literature. Following Miles and Huberman's [29] recommendations, this data analysis process was facilitated through the building of data displays in the form of tables and matrices (through coding in MaxQDA v.12.1.4) to refine the concepts identified, and the development of tentative conclusions to depict the emerging shifts.

The data analysis began with descriptive codes (or open coding) as soon as the first interviews were transcribed, and was done inductively, seeking to reflect the data as closely as possible. This stage led to the identification of over 280 descriptive coded statements. These statements were then organized into 27 different categories, such as firm specifics, initiatives due to digitization, agility, digital innovation, structure of an organization, organizational recombination, strategy etc. (these being the early interpretative codes). At this point, the focus was on interpreting the data to search for relationships and patterns and facilitate the next stage, pattern coding. The process was highly iterative, moving between data, interpretation, and theory. As our output, we identified two central emerging shifts that we structured in *knowledge recombination* and *organizational recombination*. Focusing on these shifts, we identified complementarities among them as we looked back at the data which are presented in the next section.

## 4 Results

### 4.1 Knowledge Recombination in the Digital Age

**Collecting Data to Gain Knowledge about Customers in the Digital Age.** In the conversations with the firms, we noted their necessity to collect increasing amounts of customer data to better understand customer needs and wants and to eventually adjust existing or create new services. Likewise, the CTO of a large online bank (IP04) remarks: "We want to gain more information about our customers [...]. We'd like to gain knowledge about their living conditions and their financial situation [...]. By today, we do not have the comprehensive view of the customer [...] that we would like."

For this endeavor, the firm intends to track all digital activity of their customers through their connected digital products or digital services (e.g. usage data, transaction data, location data) and to combine it with their corresponding customer master data

(e.g. profession, age). Another new challenge, according to the interviewees, is to complement their conventional user data (e.g. transaction data, product usage data) with secondary data that might initially seem unrelated (IP04: “We would even add further information such as weather data”) [30] but offer greater possibilities in predicting or concluding certain developments or desires of a customer [31]. To summarize, companies use new data sources to extend the knowledge on their customers for deeper analysis and to recombine this knowledge.

**Knowledge Recombination via Recombinant Creation.** Collecting primary data through tracking the digital activity of customers can lead to the development of new products or services as the behavior of customers may provide the firm with insights unavailable before [30–32]. Accordingly, the innovation manager (IP02) of a bank stated: “We collect all this data because it is an effective way to delineate innovations by identifying what is missing [for our customers] and where they have problems.”

This manager explained that his company analyzes when customers are aborting certain digital processes, and try to enhance these digital processes by providing their customers with, for instance, improved web page structures or more options to choose from. Then, such data is complemented by external data to further augment a firm’s knowledge about their customers and to create a comprehensive understanding of customer needs and wants. This, ideally, makes it possible to provide fitting offerings without requiring customers to enter lots of data: “In the future, [the customers] do not need to do anything because we will give [them] recommendations” (IP04).

Such recommendations can be innovative solutions that are being tailored based on the previously tracked and analyzed the digital activity of a customer combining knowledge from conventional (master data, digital behavior) and secondary (environmental) data. This way, firms add value by digitally engaging with their customers to get ideas for novel products, ideally, as we learned, in an automated way. It is of high priority to satisfy the customer’s needs following the core marketing idea of adjusting value propositions to consumer needs [33], and now this appears to be even more relevant as customer loyalty seems to become less important (IP14): “it does not matter if we want to [do this] or not. The customers will base their [banking choice] decision on where the banking experience is the easiest, most convenient or the greatest.” These insights indicate that companies try new combinations in products or services (recombinant creation) through recombining knowledge which is based on collecting and analyzing data through tracking the digital activity of customers (knowledge recombination).

**Knowledge Recombination via Recombinant Reuse.** Still, tracing digital activity is not only about becoming a “comprehensive advisor” but also about the co-creation with customers [33, 34]. This assumes that different entities (e.g. firms and consumers) cooperatively integrate their operant resources (e.g. knowledge, skills, and technology) [3] within a joint process to generate value [35]. A marketing specialist (IP11) introduces his organization’s practices as operated in the agricultural sector when they equip farms: “We do not develop one [stand-alone milking] robot per customer [...]

[where the milking robot is just one component of the entire farm]. Yet, the information relevant to our sales process are how does the customer want his farm? What is his daily need? [...] Therefore, we develop his farm in co-creation with the customer to ensure that he wants to have it.”

He underpins that the company’s approach to solving new problems (i.e. integrating a stand-alone milking robot) is using known combinations, i.e. through value co-creation with the respective customer. Therefore, the firm involves such customers as closely as possible to reduce technological uncertainty [36]: “We do not always know what we want to develop. Thus, we research a lot with our customers. We would run an algorithm in test mode to observe what this means to the customer. This way, we could improve a lot of functions, [...] and increase performance” (IP11).

Hitherto, co-creation is not a novel concept [34]. But with digitization and being permanently connected to the customer it allows for co-creation on a large scale, as pinpointed in this statement (IP03): “For testing user satisfaction, we got our ‘advisory customers’. This is an insider community of some five hundred customers which we survey continuously through digital channels.”

From this testing, the company derives how customers use new products, and identify spaces for improvement. In the following, its CTO (IP04) explains how this improvement occurred in an agile way by recapturing the development of a successful app:

“We would try to only offer this core feature [...]. This way, we can first test how the product is being perceived [...] By now, I think, that the third version of the app is available – within only four or five months [...]. Previously, we probably would have released the first version only late in summer, realizing all the other features that we have thought of. In this example, we have realized the very first functional version, and [...] rereleased further functions.”

Until recently, the traditional testing of products, i.e. imitating how clients will use products, was the means to identify potential weaknesses [37] and to ensure that new products conform with their intended functionalities [31]. In the digital age, however, companies monitor and improve their products continuously, i.e. they might compile real performance data from all products which may provide them with insights on design problems that the artificial testing did not reveal.

Accordingly, we observe that companies solve the problems of their customers (recombinant reuse) in digital co-creation through the recombination of known technological combinations supported by the collection and analysis of customers’ digital activity (knowledge recombination). Further, we derive that these activities allow for greater proximity of a firm to every individual customer through digital technology in an unprecedented automatized way. *Proximity* connotes thoroughly analyzing the digital behavior of customers as a resource for innovation ideas, as a co-creator in the development and design of products and services, and as a user in testing the product or in helping other users to learn about the product or service [3]. This means that companies focus on creating market offerings after having digitally analyzed their customers’ behavior (e.g. product usage via tracking digital activity [30, 31, 38]) and before tailoring specific affordances through a recombination of the gained customer knowledge (recombinant creation).

## 4.2 Organizational Recombination as the Complement of effective Knowledge recombination in the Digital Age

**Restructuring the Organization in the Digital Age.** In our eight case studies, we were sensitized that identifying new knowledge combinations through digital analysis, and solving problems of customers through digitally gathered knowledge, are associated with organizational recombination and eventually aimed at increased organizational agility. For instance, the agile development of products and services requires new units or functions [31, 39]. Likewise, the Chief Digital Officer of a retail bank (IP14) confers the sheer importance of becoming “more agile” and highlights how his firm’s senior management team infuses his firm: “We have identified [digital] strategic fields which we elaborate on cross-divisionally, i.e. with teams created from the different areas of the company, with the aim to develop or identify a greater need for change.”

By becoming more agile, firms want to be able to sense and respond quicker to customer-based opportunities [40, 41] to timely incorporate (‘recombine’) the knowledge gained from their digital activities. Besides, the CTO (IP07) of a large weekly explains another advantage of agile development approaches: “You just get more insight, you get insights faster, also when something goes out of control”.

Following this prospect, firms may become more agile in various areas, such as customer-based processes or interactions with supply chain partners, or to increase competitiveness [41].

**Organizational Recombination via Recombinant Creation.** Firms have long tried new organizational combinations with external partners in various ways [11, 26]. Our case studies confirmed this practice, yet the objective slightly deviates. Hence, companies would continue with the traditional integration of external partners by acquisition [11] (“Fintechs<sup>1</sup> are integrated with quite banal cooperation models. We honestly cooperate with Fintechs for many years” (IP14)), but at the same time they are trying to adopt the agile spirit of start-ups: “It is of interest for us to experience entrepreneurship. The spirit, the gut decisions, this enthusiasm [...]. I believe this ‘spirit transfer’ in the sense of digital transformation is extremely important. Especially for larger companies.”

This spirit appears to complement the co-creation between a firm and its customers (knowledge recombination) and may strengthen through solutions integrated through collaborations with startups or competitors (organizational recombination). The rationale is that startups or competitors may provide novel, legacy-free solutions for the customers of a “traditional” firm that the incumbent may have difficulties to develop due to a lack of skills, its strong hierarchy, or slow decision-making processes [14]. Hence, all firms reported integrating startups, while a subset creates incubator structures (in cases A, B, F, and G) to attract and support startups at their very founding stage [42]. Firm A also launches small spin-offs to save resources (e.g. cost, and manpower) as internal efforts are being decreased, and allow for more agile realizations compared to those of his organization due to “less organizational legacy”. However, a

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<sup>1</sup> Fintech is a synonym for start-ups in the financial industry.

product group manager (IP11) also introduced us to their shift towards operating on platforms on which they collaborate with their competitors, aiming at providing the customer with solutions to their individual problems regardless where the solution is coming from:

“We see farmPage<sup>2</sup> as a platform. We would appreciate if our competitors would be on it, too [...]. The more customers, [...] the more valuable is what you can analyze from it.” With these words, the manager highlights the notion of collaboration with competitors. He further notes that in the digital age customers are less involved with minding the origin of a solution to their problems, rather than having an organizational combination that provides them with a solution. Besides, the last part of the quote underlines how the collaboration with customers and competitors may serve as a new source for knowledge recombination. Hence, we note that companies form various new organizational combinations (recombinant creation) through the integration of external partners, i.e. start-ups, incubators, spin-offs or competitors, to increase the celerity in developing innovations.

**Organizational Recombination via Recombinant Reuse.** Besides forming new organizational combinations with external digital partners, the interviewed firms alter their internal structures by creating cross-functional teams. This brings knowledge resources closer together that were previously separated, and removes internal boundaries between them thus increasing the likelihood of knowledge recombination [43]. One manager (IP02) sketches how such teams are constituted in digital initiatives: “We do not have these silos anymore, which we had [...]. Now, all parties are in the product development: marketing, IT, legal and product managers.” This structural recombinant reuse (forming cross-organizational teams) within the organizational structure (organizational recombination) fosters the thorough engagement with a firm’s customers as the analysis of customer data and environmental data can be facilitated by various experts from heterogeneous fields (knowledge recombination) allowing a new view on existing products) [9].

In addition, the companies restructured their physical workspace to further support this cross-functional collaboration. With wide spaces without boundaries and people mingling together, knowledge is more easily shared within units than between them [44], even when activities within a unit are distant from each other [45]. One manager illustrated this for his firm (IP03): “We have started to completely restructure many of our workspaces. [...] We created larger spaces because many small offices existed in which employees got lost [...] Now, the people focus on one topic, and the cycles of product development shrunk significantly [...]. In addition, the workspace development is very, very good for our staff [...] captured on the balance sheet.” Overall, fewer divisional boundaries enable greater and wider exploration of knowledge through richer communication and joint development [46] by forming cross-departmental teams, and by co-locating people.

In the digital era, another emerging shift comes from the formation of new positions, and dedicated managers to consolidate the digital activities of a firm [30, 31]. Hence,

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<sup>2</sup> Software product name changed to assure anonymity of all interview partners and related firms.

several managers (IP02, IP08, IP04, IP14, IP16) told us they were hired to introduce initiatives to make their company more “digital”. Other companies (cases E and F) even instantiate new digital structures, such as a digital office equipped with the competence to make their company more agile. Correspondingly, a newly appointed chief digital officer (IP14) describes his current position: “Our Chief Digital Office reports directly to the CEO. I am a member of a six-member management team in the CDO department [...]. Since May last year, we made an organizational change, [...] so that I get the space to deal with the major disruptive changes in our business [...]. Now I deal with the digitization [...]. In particular, the management of innovation and in this context the exchange with startups, but also with other potential partners in the digital context.”

He summarizes how the integration of external partners is fortified through the firm’s internal restructuring. This is complemented by digitizing the customer interface for digital customer analyzes (aimed at knowledge recombination) because it simplifies the integration of external partners (organizational recombination). Through the digitization of an interface, a firm defines certain standards (i.e., APIs) which also can be used when incorporating startups, respectively their solutions into a company.

Overall, we note that companies recombine their internal organizational structure, responsibilities, and functions (organizational recombination) to be quicker at solving problems in the digital age (recombinant reuse) and to form new organizational combinations with external partners (recombinant creation). Digital co-creation (knowledge recombination) may even support this by spurring quicker product or service releases for the customers if the organization uses agile methodologies in heterogeneous teams (organizational recombination), which is reportedly integrated into the daily business practices by all managers. Our findings are depicted in Figure 1:

Recombinant Type	Area of Recombination	
	Knowledge Recombination	Organizational Recombination
Recombinant Creation	[a] Digitizing the customer interface <b>(Smart Customer Analysis)</b> Reported in: A, B, E, F	[b] Becoming more open to external partners <b>(Startups, Competitors)</b> Reported in: A, B, C, D, E, F
Recombinant Reuse	[c] Solving problems through digitally gained knowledge <b>(Digital Co-Creation)</b> Reported in: B, E	[d] Becoming more agile in development <b>(Cross-Organizational Teams)</b> Reported in: B, C, D, F, H
Identified Complementarities	Smart customer analysis [a] enhances in cross-organizational teams [d]	IP02
	Digital Co-Creation [c] improves through integrating solutions of Startups or Competitors [b]	IP11
	Digitizing the customer interface [a] simplifies the integration of Startups or Competitors [b]	IP08
	Digital Co-Creation [c] is quicker realized in agile development [d]	IP06

Figure 1. The Emerging Shifts in the Digital Age and their Complementarities

## 5. Discussion

We theoretically and empirically analyzed complementary organizational and knowledge capability recombination as pillars of a firm's digitization initiative. The results reveal consistent shifts in organizational and knowledge recombination.

**Organizations recombine knowledge elements** based on customer analysis identified in an unprecedented way which is enabled through fully digitizing the customer interface, to achieve greater proximity for deriving innovations, and to co-create products which are quickly realized. As product co-creators, customers often develop and refine product and service features that the firm incorporates into future versions [47]. Finally, customers who become expert users often discover new ways to use the product as well as shortcuts and other methods to enhance the overall value of the product.

**Organizations recombine organizational elements** by forming cross-functional teams, and by collaborating with external partners to achieve greater celerity in developing new products reflecting the customer preferences identified with the help of digitalized customer interfaces. Celerity echoes the imperatives of fast, recurrent product design, continuous product operation, and ongoing product upgrades [39] that create a need for new functional groups. In the software industry, collaborative and cross-functional software development methods like scrum have long been established. They bring together software engineers and R&D staff with IT, manufacturing, and service staff who deal with operational matters [31]. This approach rests on teams that manage product updates, shorten product cycles, and deliver new services and enhancements after the sale.

In this manuscript, we theoretically and empirically analyzed the complementarities of organizational and knowledge capability recombination. Thus, we contribute to existing research in organizational and knowledge recombination in two ways: First, we highlight that not only intra-organizational recombination of organizational elements but also inter-organizational recombination plays a role in the digital age. In addition, we extend this notion by exploring that not only investigating unit boundaries is necessary going beyond the work of Karim and Kaul [11]. Second, looking for key shifts for firms in the digital age we identify celerity and proximity as pillars of a firm's digitization initiative. Further, the results highlight complementarities between knowledge and organizational recombination for innovation that have only attracted scant recognition in the literature so far [13]. Our cases indicate that these complements may exemplify ways of becoming faster and more agile when developing digital innovations.

The results suggest some interesting implications and avenues for future research on the recombination of complementary knowledge and organizational elements (cf. Figure 1). For knowledge elements, the number of accessible knowledge elements constitutes a knowledge recombination space. Hence, combination means building networks of knowledge elements, and recombination means creating new networks. Analogously, a firm's organizational elements (i.e. structural elements such as units, teams, and cross-functional teams, both inter-organizational and intra-organizational, power distribution, and decision-making modes [14]) constitute the organizational

recombination space. Recombination then means managing boundary conditions and interventions that influence the creation of new knowledge networks [11, 48]. Drawing on the knowledge management and enterprise governance and change literature, the findings could offer a first framework for more theoretical and empirical work on digitization.

For practice, the results imply that firms increasingly pursue agile methodologies to spur faster results and use digital channels to either more thoroughly analyze or engage with a firm's customers, competitors or partners. These practices may provide direction for practitioners when navigating the enterprise into digital waters.

Future research may increasingly aim at each dimension of the emerging shifts in the digital age as illustrated in Figure 1. Hence, further organizational elements such as an organization's culture or power structure may shift in a digital context. It will also be necessary to transcend our focus on European companies and include firms from other continents and cultures.

Our research needs to be reflected in the light of its limitations. We did not use a chronological order nor an order based on popularity due to the heterogeneity of our interview partners. Instead, we ordered the findings by forming a theoretical lens (cf. Figure 1), and by following this lens' aspects to classify the identified shifts. Second, there may be a bias as two, respectively three, people attending the interviews may have intimidated the interview partners. However, we avert this by selecting one main interviewer to not overcharge the interviewee.

## **6. Conclusion**

Our research question was: *“How does the interplay of organizational and knowledge recombination relate to innovation success within a digital context?”* The analysis mainly shows that organizational and knowledge recombination complement each other leading to increased proximity to a firm's customers and to increased celerity to markets to develop novel innovations when navigating in an increasingly digital environment.

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