# Transform Me If You Can: Leveraging Dynamic Capabilities to Manage Digital Transformation

Malte H. G. Schneider, Dominik K. Kanbach, Sascha Kraus, and Marina Dabić

***Abstract*—This study sheds light on the relationships between digital transformation, business model, and process efficiency capabilities, and new product development (NPD) performance by employing a sequential explanatory approach, combining quantitative and qualitative research methodologies, utilizing structural equation modeling based on 430 questionnaire respondents, and a multiple case study design using four cases. The derived framework highlights that digital transformation does not directly lead to NPD performance but that organizations use idiosyncratic higher order (e.g., business model and process efficiency) capabilities that mediate this relationship to strategically cope with change. When assessing, reconfiguring, and integrating, organizations tap into internal and external value, individual, technological, and organizational (VITO) dimensions to transform operational capabilities and resources. Thus, higher order capabilities enable organizations to leverage firm-external opportunities to adjust intrafirm operational capabilities, resources, and competencies, emphasizing a complex hierarchical and contextual interplay. The contributions of the study are twofold: 1) we provide statistical evidence that the business model and process efficiency capabilities are coping mechanisms to master digital transformation and 2) the successful orchestration of VITO dimensions is essential for assessing, reconfiguring, and integrating resources, competencies, and operational capabilities to derive NPD performance.**

***Index Terms*—Digital transformation (DT), dynamic capabilities, mixed method, multiple case study, new product development (NPD), sequential explanatory approach, structural equation model.**

## I. Introduction

NEW technologies such as artificial intelligence (AI), three-dimensional printing, and digital twins are gaining considerable momentum, constantly challenging established markets, generating new opportunities, revolutionizing product development processes, and disrupting business models [1], [2], [3], [4], [5]. The recent explosion of digital technologies brought digital transformation (DT) not only to the forefront of academic discussion [6] but also increased managerial attention [7]. DT is a multidimensional construct that affects the whole organization by injecting digital technologies into processes, products, and business models to reformulate value propositions and stakeholder interactions [8], [9], [10]. In general, DT is the strategic use of digital technologies to fundamentally reshape business processes, customer experiences, and organizational culture. It involves leveraging innovations like artificial intelligence, cloud computing, and data analytics to drive efficiency, innovation, and competitive advantage in an increasingly digital world. The resulting interconnectivity of products, machines, and devices heralds a digital era where digitally transformed organizations establish a technology push in their industry, profiting from various advancements to edge competition and, therefore, sustain a competitive advantage [11], [12], [13], [14], [15], [16]. In their efforts to acclimatize to the new normal, possessing suitable dynamic capabilities is a necessity for reconfiguring resources and competencies to allow organizations to capitalize on these digital opportunities [17], [18], [19]. However, DT calls for a thorough approach to avoid wasting resources and overstretching capacities, capabilities, and cognitive abilities to accommodate change [7], [20], [21]. Thus, DT should not be taken lightly (e.g., uncertainty) because its implementation pressures organizations [22].

Unsurprisingly, considering the disruptive nature of DT, which creates market disequilibria by blurring business boundaries, the innovation management literature has mushroomed over the past decades [3], [7], [8], [13], [23]. Despite the significant increase in academic interest, the research has not yet explored all facets of DT because it is still in its infancy [5], [7], [10], [24]. Building on several conceptually and qualitatively derived models (e.g., [8], [25], [26], [27], [28]), our study plugs into the ongoing discussion of DT and its implications, influence, and consequences for new product development (NPD) performance, [7] adopting a dynamic capability perspective [29]. NPD performance is a critical measure of an organization's innovation capability and competitiveness in the market. It involves a series of interrelated activities, from idea generation to product design, testing, and market launch. The efficiency and effectiveness with which these tasks are executed determine an organization's ability to stay ahead of competitors, meet customer needs, and adapt to evolving market demands.

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Studying this triad presents valuable opportunities to enrich ongoing academic discourse for three primary reasons: first, because DT continues to reshape industries, understanding these connections can drive economic growth and societal progress by fostering innovation, job creation, and improved products and services. Second, organizations, that possess a nuanced understanding of how to leverage DT and dynamic capabilities to enhance NPD performance, secure a competitive edge translating into accelerated innovation, swifter adaptation to changing market conditions, and more effective delivery of value to customers. Third, examining this triad helps organizations allocate resources more efficiently, enabling them to prioritize investments in DT initiatives and dynamic capabilities that yield the highest impact on NPD performance.

Unfortunately, research connecting DT, dynamic capabilities, and NPD performance remains underdeveloped, often separately investigating dynamic capabilities for DT (e.g., [30]) or the outcomes (e.g., NPD performance) of dynamic capabilities (e.g., [31]) and producing disparate advances. More precisely, this study addresses Warner and Wäger's [28] and Ellström et al.'s [30] suggestions for complementary research contextualizing the connections of DT, dynamic capabilities, and performance using quantitative-grounded approaches. Furthermore, the research argues that dynamic capabilities should explore and exploit external sources of innovation (e.g., customers, suppliers) [32], suggesting a "complex interplay of environmental and internal factors" [33, p. 2] to assess, reconfigure, and integrate digital technologies by influencing operational capabilities [25], [34], [35], [36], [37]. Therefore, modeling causal mechanisms to investigate how to derive NPD performance, including context-specific explanations, "is a particularly meritorious endeavor" [26, p. 406].

We seek to fill this gap by answering two main research questions (RQ) focusing on the firm level. First, we test our conceptual model by applying structural equation modeling (SEM) as proposed by Hair et al. [38], introducing a causal link between DT (independent variable) and NPD performance (dependent variable) by adding dynamic capabilities as mediators (RQ1: How are DT, dynamic capabilities, and NPD performance connected?). Second, we extend our model with qualitative research using a multiple case study approach [39] to gain a deeper understanding of the internal and external dimensions that are assessed and reconfigured when conducting DT (RQ2: Which contextual dimensions and sources of knowledge are assessed, reconfigured, and integrated when pursuing DT?).

Consequently, our research design follows a sequential explanatory (mixed method) design [40], [41]. Thus, we provide theoretical and practical contributions and opportunities for a more in-depth academic discussion and further research. Our contributions are twofold: 1) we propose a causal path-dependent framework that connects DT, dynamic capabilities, and NPD performance and 2) we show that coping with DT requires assessing, reconfiguring, and integrating insights from internal and external contextual dimensions [value, individual, technological, and organizational (VITO)], thus, embedding quantitative and qualitative findings to present an extended model.

## II. Theoretical Background and Hypothesis Development

### A. Dynamic Capabilities

Managing rapid, dynamic, and disruptive change requires organizations to review their resources, capabilities, and competencies to adequately cope with new environmental realities [30]. DT introduces a new reality, that is, a fundamental change process driven by digital technologies and answered by the strategic use of key competencies to redefine business logic and processes [8], [27]. Because DT is not only ubiquitous but also surrounded by uncertainty, the dynamic capability view (DCV) [29] emerges as an appropriate theoretical lens for studying this phenomenon [7], [28], [31]. Dynamic capabilities are commonly defined as "the firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments" [29, p. 516]. Eisenhardt and Martin [42] extended this perspective, accentuating that dynamic capabilities are used to assess, reconfigure, and integrate opportunities to cope with market change. Emerging from the resource-based view [43], [44], the research highlights that DCV better encapsulates competitive-advantage building in dynamic environments (e.g., [45]). Furthermore, Helfat and Winter [46] underline the role of dynamic capabilities in producing performance outcomes.

Because DT threatens organizations on multiple dimensions (e.g., business logic, processes), leveraging appropriate dynamic capabilities allows them to adapt systematically and continuously to stay competitive to cope with environmental change [10], [31]. From a hierarchical perspective, the dynamic capabilities necessary for DT are of a higher order, stretching beyond operational capabilities and routines or stationary processes used for ordinary operations; they are neither ad hoc responses nor routines [30], [47], [48], [49]. Furthermore, these higher order capabilities "govern the rate of change of operational capabilities" [36, p. 621], ensuring evolutionary fitness and competitiveness [37], [50]. Mele et al. [25] propose that appropriate capabilities in the new digital normal are higher order context-dependent capabilities that interact with lower order capabilities and internal and external knowledge sources.

Specifically, given that research argues that DT triggers, for example, business model and process innovations, each organization possesses idiosyncratic "overarching" [47] business model and process efficiency capabilities (PEC) that support them in thriving in dynamic environments and changing organizational microfoundations (e.g., HR) [34] and combine internal and external perspectives [25], [32], [33]. This suggests that higher order capabilities are responsible for shaping operational capabilities in a top-down manner and are suitable for studying performance-related outcomes [46], [49], [51]. Therefore, we see dynamic capabilities as appropriate enablers of continuous change [3]. Business model and PEC represent an organization's response to address DT challenges, such as altering business models or process frameworks. These capabilities enable organizations to redefine how they generate, convey, and deliver value. Consequently, organizations that effectively harness these specific dynamic capabilities maximize potential benefits of DT. More precisely, we argue that to cope with change (i.e., DT), organizations strategically leverage unique business model and PEC to derive NPD performance [1], [8], [28], [52], shedding their shell to allow agile responses to avoid static resource disadvantages [53].

However, disagreements persist about the role (e.g., mediating, moderating) of dynamic capabilities. They do not automatically create performance; instead, several studies highlight that their indirect effect (e.g., mediating impact) and their context-specific deployment determine their implications for performance (e.g., [31], [49], [50], [51], [53], [54], [55], [56], [57]). We follow this line of argumentation because dynamic capabilities not only sense or seize but also transform [37]—sometimes organizations alternate between these overlapping activities [58]—suggesting an iterative facilitating role between change (i.e., DT) and a specific outcome (i.e., NPD performance). Therefore, we propose that business model and PEC (as strategic coping mechanisms) (indirectly) increase NPD performance. It follows that (H1) PEC are positively associated with NPD performance and that (H2) business model capabilities (BMC) are positively associated with NPD performance.

### *B. Digital Transformation, Process Efficiency, and New Product Development*

The proliferation of digital prospects presents a vast array of opportunities, which puts pressure on enterprises to recombine and deploy the capabilities necessary to develop new products [18], [19], [21]. Furthermore, DT breaks the value creation, delivery, and capture trajectories of products [9], which results in extended offerings [10], for example, through service-coupled product bundles (e.g., [59], [60], [61]) or connecting multiple products to develop a value ecosystem that amplifies the benefits of individual offerings [11], [13], [14], [17], [62]. Organizations increasingly democratize product development through collaborative ecosystems, networks, supply chains, or cocreation platforms to support entrepreneurship and innovation [12], [13], [16], [17], aiming to absorb knowledge to reach flexibility and product individualization able to withstand fast-changing market conditions [62]. Not only does DT ease access to knowledge as collaboration boundaries disappear [13], but it also helps to store, analyze, and leverage mass amounts of data [15] to derive insights that support decision-making [63], leading to improvements in NPD. Thus, DT propels digitization in processes, unlocking automatization, knowledge, and resources, altering internal and external collaboration, and increasing productivity and efficiency [62].

Launching new products at warp speed provides organizations with several advantages, such as first-mover or time-based advantages, improving performance [64], [65] as organizations predominantly shift toward delivering value in the least amount of time possible due to vast-changing unstable market environments [66]. As Marion and Fixson [67] note, DT accelerates iteration and experimentation activities that reduce time and costs and increase efficiency by speeding up NPD. However, the research presents inconclusive results. Whereas several studies suggest that NPD efficiency can increase performance (e.g., [68], [69], [70], [71], [72]), others demonstrate that speeding up NPD can jeopardize performance (e.g., [73], [74], [75]). Arguably, faster product launch does not automatically translate into benefits [74], [76], [77], [78] but, in combination with DT, advances the organizations' potential to reach accessible markets by accelerating their NPD, which comes with improved performance [10], [14], [67], [79]. Therefore, digitally embedded NPD processes bear enormous potential for rapid NPD as mass data availability (e.g., [15]), smart connected devices (e.g., [59]), and ecosystems (e.g., [13]), among others, flourish, underpinning the performance-growth potential of new products.

Consequently, organizations can investigate and exploit digital opportunities to identify potentially fruitful combinations for developing and launching new innovative products if they have the necessary dynamic capabilities [17]. Since DT has enormous potential for process efficiency (e.g., automatization), possessing adequate related dynamic capabilities is crucial to sustaining NPD performance [27], [28], [46]. We propose that (H3) DT positively influences NPD performance, that (H4) DT is positively associated with PEC, and that they (H5) mediate the influence of DT on NPD performance.

### *C. Digital Transformation, Business Models, and New Product Development*

DT redefines the status quo of how an organization can generate value and acquires a competitive edge over competitors because of its overwhelming and unprecedented prospects [7], [4], [80]. When an organization discovers a potentially lucrative digital opportunity, it naturally considers how it might incorporate this opportunity into its existing business model to increase its chances of gaining a market advantage [81]. According to Teece [82, p. 186], "technological innovation often needs to be matched with business model innovation if the innovator is to capture value." Business models, which serve as a type of competitive differentiation, define the distinct framework of value creation, delivery, and capturing methods for commercializing the innovations of an organization [24], [52], [82]. The integration of digital technologies or opportunities often requires several business model changes [82] "to create and capture value [ …] [to] generate revenues and define value propositions" [83, p. 465] as a strategic response [10], [84], [85] to redefine how organizations approach existing or new markets. As a result, DT paves the way for several opportunities for organizations to adapt to the increasingly competitive business environment [86], [87].

When organizations innovate their business model, the NPD process requires modifications to allow for the seamless integration of innovations and fully unleash the value potential of the innovative business model logic [61], [82], [83], [88]. This interdependence of business models and NPD [89] shows that applying new business model logic entails change. As Amit and Zott [18] note, modifying only business models or only products may not be sufficient to derive NPD performance advantages. Furthermore, DT drives the transition toward a data-based and knowledge-dominated business logic, which puts pressure on manufacturing companies to embrace and deploy dynamic capabilities to develop new products as a kind of competitive differentiation strategy [9], [60], [90].

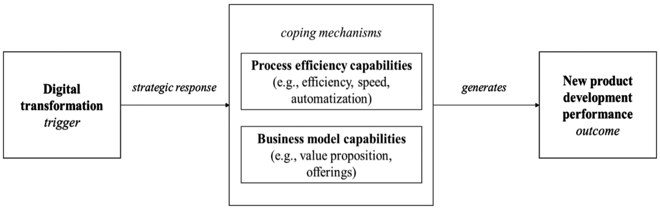


Fig. 1. Conceptual model.

Specifically, organizations following a digital-centric business model approach, reformulating their value proposition, and aligning their strategic focus benefit from DT [16], [84], [87], [91]. Clearly, "new digital technologies [ . . . ] [signal] the need for firms to transform their business digitally" [10, p. 890], and organizations that are unable to change their business model may not survive digital technological shifts [92].

Because the recombination of business model logic allows organizations to disassemble and reassemble core functions, competencies, and resources [30], [52], [82], BMC play an important role in coping with change and generating performance outcomes [3]. Thus, we propose that (H6) DT is positively associated with BMC, and that they (H7) mediate the influence of DT on NPD performance.

### *D. Conceptual Model Derived From Theoretical Line of Argumentation*

Fig. 1 outlines our conceptual model and captures the main line of argumentation outlined above, in which DT (independent variable) pushes organizations to use their dynamic capabilities (i.e., business model and process efficiency) as a coping mechanism to generate NPD performance (dependent variable). We test the proposed conceptual model (quantitatively) and enrich it with additional insights as well as add finer grained explanations (qualitatively) to derive a comprehensive picture.

## III. METHODOLOGY

As suggested by Creswell and Clark [40] and Ivankova et al. [41], we follow a sequential explanatory research design using SEM followed by multiple case research to answer our RQs (see Fig. 2). This research design is "well suited if a researcher needs additional qualitative information to explain [ . . . ] findings" [93, p. 375]. Adding a qualitative perspective allows us to "refine and explain those statistical results [ . . . ] for the exploration of the quantitative results in more detail" [41, p. 5]. By applying SEM [38], we establish relationships among DT, business model and PEC, and NPD performance (RQ1). Because establishing relationships alone is not sufficient to derive conclusions about them, we integrate case research [39], focusing on a multiple case study for a deeper problematization and epistemological reflection enriching the quantitative results with a deeper context. Precisely, the qualitative analysis highlights how business model and PEC interact with internal and external contextual dimensions to reshape resources, competencies, and capabilities in response to DT (RQ2).

To increase readability, we present the quantitative approach and results first, followed by the qualitative approach and results and the integration of both phases (see Figs. 2 and 4).

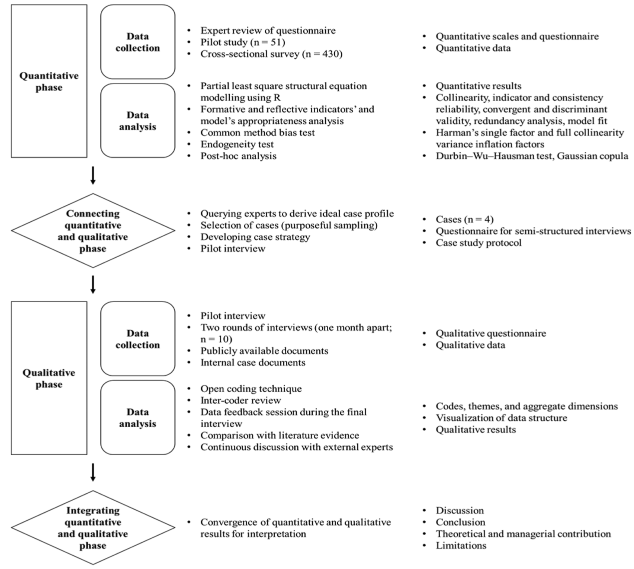


Fig. 2. Our sequential explanatory research design adapted from Ivankova et al. [41].

Consequently, the results from both analyses expand our initial conceptual framework (see Fig. 1) providing a comprehensive research model (see Fig. 4). Hence, the core of our extended research model builds upon the quantitative results (see Fig. 3) adding the insights generated from our qualitative findings (see Table VIII). This procedure enhances the merits of a sequential explanatory research design in several ways. First, it validates quantitative findings with qualitative insights, enhancing the credibility and robustness of the study through data triangulation. Second, this approach is especially advantageous for researching complex phenomena where multiple variables and factors interact. Therefore, it overcomes the challenge of comprehending the entire landscape by providing a richer and more holistic understanding than using either method in isolation. Third, additional qualitative data can provide context and meaning to quantitative results enabling researchers to gain a more comprehensive overview of the observed phenomenon by initially collecting quantitative data to identify patterns and then delving deeper with qualitative data to explore underlying reasons and nuances.

## IV. SEQUENTIAL EXPLANATORY APPROACH AND RESULTS

### *A. Quantitative Approach Applying Structural Equation Modeling*

*1) Data Collection:* We adopt a two-step data collection approach. We developed our questionnaire using established and verified items from previous research (DT [62], [94]; BMC [2], [81]; PEC [70], [95]; NPD performance [2], [73]), slightly adjusting them to fit our study (see Appendix I for scale-item details). The questionnaire participants were selected (with the help of a commercial provider; e.g., [96]) from organizations facing digital-transformation challenges that have launched or plan additional digital-transformation activities (e.g., projects, CxO, hubs) with broad cross-industry coverage. In addition, the participants work in organizational units responsible for

TABLE I
OVERVIEW OF QUESTIONNAIRE PARTICIPANTS IN THE FINAL DATASET ($N = 430$)

| Firm size | $N$ | fparticipants (%) | Mgmt. (%) | Median yrs. exp. | Ø confidence |
|---|---|---|---|---|---|
| < 10 | 43 | 50.47 | 72.09 | 10–14 | 4.07 |
| 11–49 | 70 | 47.14 | 42.86 | 4–9 | 4.31 |
| 50–249 | 99 | 43.43 | 50.51 | 4–9 | 4.08 |
| 250–499 | 49 | 44.90 | 34.69 | 4–9 | 4.16 |
| 500–999 | 54 | 61.11 | 46.30 | 4–9 | 4.37 |
| 1000–10 000 | 73 | 45.21 | 34.25 | 4–9 | 4.15 |
| >10 000 | 42 | 52.38 | 28.57 | 4–9 | 4.31 |
| *Data set* | 430 | 49.30 | 44.19 | 4–9 | 4.20 |

Note: Firm size represents the number of employees, fparticipants is the number of female questionnaire participants, Mgmt. refers to management positions, Median yrs. exp. indicates the median years of professional experience, and Ø confidence is the average level of confidence (1 = very unconfident to 5 = very confident). The median age of the questionnaire participants ranges from 26 to 35 years (min. 18 - 25; max. > 65).

TABLE II
DESCRIPTIVE STATISTICS AND CORRELATION MATRIX OF THE VARIABLES

| Variables | Mean | S.D. | DT | BMC | PEC | NPDP |
|---|---|---|---|---|---|---|
| Digital transformation | 5.492 | 1.110 | | | | |
| Business model capabilities | 4.817 | 1.195 | 0.480 | | | |
| Process efficiency capabilities | 4.255 | 1.343 | 0.390 | 0.580 | | |
| New product development performance | 5.235 | 1.012 | 0.320 | 0.520 | 0.570 | |

Note: n = 430. Correlation coefficients are shown below the diagonal and p-values above the diagonal.

TABLE III
INTERNAL CONSISTENCY RELIABILITY AND CONVERGENT VALIDITY MEASURES

| Variables | α | CR | AVE |
|---|---|---|---|
| Digital transformation | 0.923 | 0.904 | 0.655 |
| Business model capabilities | 0.882 | 0.904 | 0.612 |
| Process efficiency capabilities | 0.893 | 0.910 | 0.718 |
| New product development performance | 0.887 | 0.890 | 0.623 |

Note: α (Cronbach's alpha) and CR (composite reliability) should exceed 0.700 but be below 0.950 to prevent indicator redundancy, while the AVE (average variance extracted) should exceed 0.500. The appropriateness of these results is supported by the congeneric procedure proposed by Marzi et al. [116].

TABLE IV
DISCRIMINANT ANALYSIS

| | Fornell-Larcker criterion | | | | Heterotrait-monotrait ratio | | |
|---|---|---|---|---|---|---|---|
| | DT | BMC | PEC | NPDP | | | |
| DT | 0.812 | | | | | | |
| BMC | 0.545 | 0.782 | | | 0.542 | | |
| PEC | 0.415 | 0.574 | 0.845 | | 0.415 | 0.645 | |
| NPDP | 0.397 | 0.566 | 0.630 | 0.787 | 0.364 | 0.578 | 0.634 |

Note: $n = 430$. Correlation coefficients are shown below the diagonal and $p$-values above the diagonal.

TABLE V
MODEL REDUNDANCY AND CONVERGENT VALIDITY ANALYSIS USING GLOBAL SINGLE ITEMS

| | DT global | BMC global | PEC global | NPDP global |
|---|---|---|---|---|
| $R^2$ | 0.444 | 0.325 | 0.625 | 0.528 |
| Adj. $R^2$ | 0.443 | 0.321 | 0.624 | 0.527 |
| ▲ | 0.667 | 0.585 | 0.791 | 0.726 |

Note: ▲ values should exceed 0.708 (with values around 0.600 acceptable). ▲ is a placeholder for the variable (i.e., DT, BMC, PEC, NPDP). As suggested by Hair et al. [38], we conducted goodness-of-fit measures by computing global items that adequately reflect the construct under consideration as appropriate measurements. Cheah et al. [104] show that redundancy values for path coefficients decrease with increasing sample size. Thus, we conclude that our model produces sufficient levels of convergent validity as values of 0.600 are deemed acceptable.

technology, innovation, and DT and, thus, possess the knowledge and experience required to answer our questionnaire. We double-checked whether participants meet our requirements by asking them to provide more information about their organization's DT activities and their job title and description. By ensuring that strategic (e.g., top management), tactical (e.g., middle management), and operational (e.g., employees) perspectives are covered, we increased the holisticness of the insights.

Consequently, before collecting the data, we incorporated an expert assessment to guarantee the readability, rigor, and precision of our research design. We then created a pilot questionnaire to collect responses from 51 participants. We eradicated oddities and other flaws by incorporating the generated insights and leveraged the observations from the pilot study to refine our questionnaire and increase its general appropriateness. We finalized the questionnaire by defining several quality thresholds, such as a confidence check (from 1 = very unconfident to 5 = very confident), the number of DT projects taken part in (at least 1), educational background (at least undergraduate degree or higher), and frequency of technological use at work (at least once a week).

The final dataset consists of 430 valid gender-balanced responses (see Table I), spanning a wide range of industries (e.g., construction, healthcare, metal, and pharmaceuticals), professional experience (up to >30 years), firm sizes (up to >10 000 employees), and hierarchy levels (approximately 44% of the participants hold a management position).

*2) Data Analysis:* We apply partial least square structural equation modeling (PLS-SEM) to analyze our data using the statistical software tool R (version 4.3.0). PLS-SEM is useful to our research for two main reasons: 1) it excels at estimating causal-predictive explanations and 2) it overcomes the dichotomy between explanation and prediction [97]. The items are assessed using a seven-point Likert-type scale from "strongly disagree" (1) to "strongly agree" (7) because of its accuracy compared to other scales.

Following the steps proposed by Hair et al. [38], [97], we closely adhere to the suggested quality thresholds to ensure our formative and reflective model's appropriateness (see Table II). Thus, we test for indicator and structural model collinearity issues [variance inflation factors (VIF) < 5] and indicator reliability (>0.708), internal consistency reliability and convergent validity by calculating Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE) (see Table III). In addition, we check discriminant validity using the Fornell–Larcker criterion and heterotrait–monotrait ratio (see Table IV), perform redundancy analysis by forming global single items (see Table V), verify model-fit measures by applying a combinatorial approach suggested by Hu and Bentler [98] (see Table VI), and test the model's explanatory power ($R^2$) and

TABLE VI
MODEL FIT MEASURES

| CFI | RNI | TLI | GFI | AGFI | RMSEA | SRMR |
|---|---|---|---|---|---|---|
| 0.948 | 0.948 | 0.928 | 0.887 | 0.855 | 0.071 | 0.056 |

Note: CFI (comparative fit measure), RNI (relative noncentrality index), TLI (Tucker-Lewis index), and (A)GFI ([adjusted] goodness-of-fit index) should exceed 0.900 (conservative cutoff 0.950). RMSEA (root mean square error of approximation) values below 0.080 [105] are considered acceptable (conservative cutoff 0.060). SRMR (standardized root mean square residual) should be below 0.080 and $\chi 2$/df value equals 3.188 ($\chi 2$ = 522.891; df = 164.000; $p$-value = 0.000 and should be below 5. We evaluate CFI and SRMR, and RMSEA and SRMR combinations, which suggest adequate model fit.

the model's predictive power (PLSpredict) by conducting $k$-fold cross validation comparing the root mean square error (RMSE) of PLS-SEM with the RMSE of a linear regression model (LM) benchmark (RMSE PLS-SEM < RMSE LM). We also test the statistical significance and relevance of indicators by conducting bootstrapping procedures to decide on indicator deletion (see Appendix I). In addition, we use firm size, industry, and participants' age, gender, and role as control variables and integrate a post-hoc analysis to ascertain generalizability (we created subsamples discriminating between hierarchical roles (e.g., top vs. bottom view) to confirm that the results hold (see Fig. 3).

Hu and Bentler [98] derived several cutoff values to assess model fit using a simulation-based study design, which has received some critical appraisal (e.g., [99]). West et al. [100] acknowledge the aforementioned studies while noting that cutoff values require a cautious evaluation that holistically considers and interprets model-fit measures, proposing a combinatorial approach and thus, being aware of potential risks before jumping to fraudulent conclusions. Considering these studies and their conclusions as well as the results of our model- fit indices (CFI = 0.948; RNI = 0.948; TLI = 0.928; GFI = 0.887; AGFI = 0.855; RMSEA = 0.071; SRMR = 0.056; $\chi 2$/df = 3.188), our model displays adequate fit (see Tables III, IV, V, VI).

Also, we validate the robustness of our latent variables applying the congeneric approach proposed by Marzi et al. [116] employing exploratory factor maximum likelihood analysis and weighted average score estimations to verify our factor loadings, constructs statistics (Cronbach's alpha, CR, AVE), and constructs fit indices (RMSEA, SRMR, TLI, CFI). Furthermore, because we ensure anonymity, separate questionnaire sections, calculate Harman's single factor (<0.5), conduct confirmatory factor analysis, and check full collinearity VIF (<3.3), we conclude that common method bias is not an issue [101], [102]. In addition, testing for endogeneity in PLS-SEM, we follow the procedure proposed by Hult et al. [103]. Consequently, we run a Gaussian copula analysis including the Kolmogorov-Smirnov test of non-normality of variables ($p$ < 0.05), the two-stage least-squares regression procedure, and the Durbin–Wu–Hausman test. The combined results suggest that endogeneity is not a concern.

### *B. Quantitative Results Utilizing Structural Equation Modeling*

Fig. 3 visualizes our structural equation model, which shows the constructs' relationships, the path estimates of the base

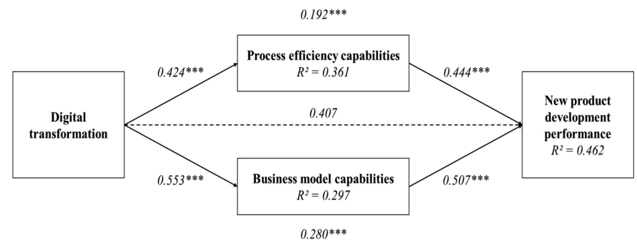


Fig. 3. Structural equation model. Note: Solid lines indicate hypotheses that are supported, whereas dotted lines show hypotheses that are not supported. $***p < 0.01$; $**p < 0.05$; $*p < 0.10$. DT->BMC->NPDP and DT->PEC->NPDP indirect-only (full) mediation. Control variables: firm size, industry, participants' age, participants' gender, and participants' role. Post-hoc analysis: creation of subsamples discriminating between hierarchy levels to determine whether the results hold.

TABLE VII
RESULTS OF THE STRUCTURAL EQUATION MODEL

| | Estimate | t-value bootstrap | Hyp. | Result |
|---|---|---|---|---|
| *Base model* | | | | |
| PEC -> NPDP | 0.444 | 9.316*** | H1 | supported |
| BMC -> NPDP | 0.507 | 4.744*** | H2 | supported |
| DT -> NPDP | 0.407 | 1.293 | H3 | not supported |
| DT -> PEC | 0.424 | 10.296*** | H4 | supported |
| DT -> BMC | 0.553 | 14.477*** | H6 | supported |
| *Mediation analysis* | | | | |
| DT -> PEC -> NPDP | 0.192 | 6.806*** | H5 | supported |
| DT -> BMC -> NPDP | 0.280 | 4.411*** | H7 | supported |
| *Explanatory power* | *$R^2$* | *Adj. $R^2$* | | |
| PEC | 0.361 | 0.354 | | |
| BMC | 0.297 | 0.295 | | |
| NPDP | 0.462 | 0.458 | | |

Note: The t-value bootstrap is computed using 10,000 subsamples. $R^2$ values around 0.500 signal adequate explanatory power. $***p < 0.01$; $**p < 0.05$; $*p < 0.10$. DT->BMC->NPDP and DT->PEC->NPDP indirect-only (full) mediation (tested using bootstrap analysis with a 95% confidence interval).

model, and the hypotheses (RQ1, see Table VII). We proposed that process efficiency (H1) and business model (H2) capabilities are positively associated with NPD performance. Our results support both hypotheses ($\beta = 0.444$, $t = 9.316$, $p < 0.01$ and $\beta = 0.507$, $t = 4.744$, $p < 0.01$, respectively). However, we find no support for DT's direct impact on NPD performance (H3) as the effect is not significant ($\beta = 0.407$, $t = 1.293$). For our hypothesized influence of DT on process efficiency (H4) and business model (H6) capabilities, we derive significant positive effects supporting both hypotheses ($\beta = 0.424$, $t = 10.296$, $p < 0.01$ and $\beta = 0.553$, $t = 14.477$, $p < 0.01$, respectively).

Our model contains two proposed mediation effects: first, PEC mediate the effect of DT on NPD performance (H5); second, BMC mediate the effect of DT on NPD performance (H7). The results are positive and significant for all the proposed mediation effects, supporting H5 ($\beta = 0.192$, $t = 6.806$, $p < 0.01$) and H7 ($\beta = 0.280$, $t = 4.411$, $p < 0.01$). We examine the product of the direct and indirect effects (p1 · p2 · p3) to estimate the type of mediation. Because the products of the direct and indirect effects generate positive results for all examined mediations, the mediation analysis yields an indirect-only (full) mediation (the direct effect is not significant, the indirect effect is significant, and the product of both is positive) for H5 and H7 (see Table VI for details).

TABLE VIII
DATA STRUCTURE AND VITO DIMENSIONS

| First-order concepts (in-vivo quotes) | Second-order themes | Aggregate dimension |
|---|---|---|
| "… digital technologies offer value potential, but the value added needs to be streamlined internally and externally…"<br>"… although we are much faster, the value added must be easily visible and noticeable…"<br>"… several projects focus too much on internal value effects […] to achieve sustainable value creation also for external stakeholders [e.g., customers], we need a stronger collaboration among every value-creating partners …"<br>"… digital transformation means rethinking how we create value […] thus, using all value levers establishing a continuous value flow …"<br>"…copying value promises to a digital context is insufficient because the targeted audience requires a novel approach …" | • Value complexity, efficiency, and practicability<br>• Value conduit, ecosystem, and proposition<br>• Value (co-)alignment (internally and externally)<br>• Holistic go-to-market approach (e.g., market offerings) | Value dimension |
| "… we do have a digital transformation strategy; however, half do not understand it, and half do not know it …"<br>"… you need adequate skills across all departments and levels; from R&D over sales …"<br>"… breaking individual barriers is crucial … "<br>"… digital transformation means change, and change never comes easy […] so supporting, encouraging, and driving change is necessary …"<br>"… digital sounds new and unfamiliar. Without communicating the opportunities to employees […] usage and acceptance is limited …" | • Digital capabilities (individual level)<br>• Change readiness (individual level)<br>• Digital orientation (individual level)<br>• Adoption and implementation behavior (individual level)<br>• Action potential and boundaries of usage<br>• Incentivization and appraisal | Individual dimension |
| "… errors and problems of technologies are problematic …"<br>"… data regulation and other policies. We might develop faster, but the actual benefit comes from, [e.g.], leveraging data …"<br>"… we must stop building separated systems with unique technologies […] and create some kind of new product development platform …"<br>"… integrate digital technologies seamlessly in existing systems …"<br>"… production gets much easier, but consider this: (re-)charging takes absurdly long […], transferred to digital technologies, functionality is key …" | • Technological readiness<br>• Manufacturing readiness<br>• Connectivity and seamless embedment of technology<br>• Technology affordance<br>• Functionality of technology<br>• Regulatory and policy concerns | Techno-logical dimension |
| "… it is hard to change a running […] system and replace it with the perceived unknown risky digital-based system…"<br>"… we cannot consider digital transformation a short-term project where product performance manifests shortly […] with organizations, processes, products, and stakeholder require time to acclimatize…"<br>"… digital transformation requires a whole new approach how to do business and design products with a well-designed infrastructure…"<br>"… a process is fragile. Several steps are fast, advantageous […], but one flawed step disturbs the process, yielding no benefit whatsoever…"<br>"… our AI tool is like a seed; you need to nurture it, give it attention, cut branches that hinder growth, water it. Then it flourishes …"<br>"… you can get lost in the digital opportunity jungle, feeling overwhelmed, losing focus, don't know where to start, and making bad decisions…" | • Digital capabilities (organizational level)<br>• Change readiness (organizational level)<br>• Adoption and implementation behavior (organizational level)<br>• Digital orientation (organizational level)<br>• Manufacturing process (e.g., agile, flexible, connected)<br>• (Strategic) focus and (holistic) organizational integration<br>• Digital strategy<br>• Digital infrastructure<br>• Operating model | Orga-nizational dimension |

### C. Qualitative Approach Applying Case Research

*1) Data Collection:* Meeting quality thresholds for conducting case research (see Appendix II for details) requires a dedicated case approach [39], [106]. Choosing cases that support our search for possible explanations of significant (nonsignificant) PLS-SEM results necessitates purposeful sampling. After aligning our case approach, we sought an expert assessment. We thus gained a better understanding of suitable cases and developed an ideal case profile by questioning experts from industry and digital hubs. Furthermore, before data collection, we established the protocol for our case study and included an expert review to increase its suitability and overall quality. In addition, we conducted pilot interviews to modify our interview guidelines.

During the case selection process, we carefully evaluated several critical criteria. Following Ivankova et al. [41], our goal was to find cases from the quantitative part illustrating the industries that were most represented among the participants (e.g., construction, healthcare, metal, pharmaceuticals) enriching the depth and breadth of our study. Thereby, we aimed for representativeness, typicality, and a cross-industry perspective in our qualitative dataset. In addition, we have prioritized cases for which we can access sufficient data engaging in discussions with managers in potential target organizations to identify experts and data suitable for our research. Because incumbent organizations often struggle with (digital) transformation, reluctantly adapting to change, we focus on established firms (and not on born-digital ventures) that have launched and pursued DT initiatives in the past (e.g., new strategy, hubs, addition of CxO). Using these criteria, we systematically organized cases into distinct lists categorized by industry and selected the most appropriate case for our study.

The data-collection process contains two collection rounds one month apart ($n = 10$, five interviews each round), where the final interview also serves to validate evidence (e.g., interviewee feedback). Each interview was recorded, and extensive handwritten notes were taken. The interviews focus on two overarching questions to understand the influence of business model and PEC: 1) "Which resources, competencies, and capabilities do you utilize when pursuing DT?" and 2) "Which (internal and external) dimensions do these capabilities assess when responding to the integration of digital technologies?" Additional questions were asked at the end of each interview to collect further information about DT, dynamic capabilities, and NPD that may not have been covered but seemed relevant. On average, the interviews lasted 78 min ($n = 10$; 780 min total). The final data set, comprised of four cases, consists of semi-structured interviews and internal and publicly available documents (e.g., management presentations and meeting notes) for data triangulation. We anonymize the cases as "A," "B," "C," and "D" (see Appendix III for details).

*2) Data Analysis:* To analyze the collected qualitative data, we use an open coding technique proposed by Corbin and Strauss [107]. In addition, a structured approach is needed to comprehensively present the findings; thus, we follow the explanation-building iterative steps put forward by Yin [39]. Collecting interview data in two separate rounds allows us to identify an initial set of categories, which we refine and enhance after completing the final round based on all accumulated data.

To illustrate our qualitative analysis (see Table VIII), obtained from a comparison of cross-case data, we develop first, second, and aggregate categories based on in vivo interviewee statements. We used these in vivo quotes to move from unstructured data toward systematically clustering and merged clusters based on their similarities to derive first-order concepts. Then, we applied axial coding to sort and organize these first-order concepts into broader sets of second-order themes based on shared relationships and thematical overlaps. At this stage, we purposefully

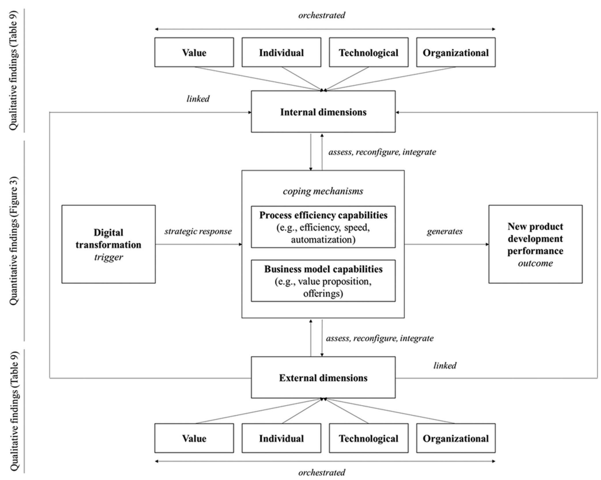


Fig. 4. Model extended by the quantitative (see Fig. 3) and qualitative (see Table VIII) results.

reviewed additional case data (e.g., management presentations, meeting notes) to further develop and refine our second-order themes, ultimately leading to the derivation of our aggregate dimensions. Considering the possibility of convergence biases, we carefully evaluated the data structure with literature evidence and employed constant comparison to iteratively refine and expanded the coded data.

To increase coding rigor, the initial and final data structure includes an inter-coder review, with potential conflicts solved by comparing literature evidence and other collected case data. Because we engaged in several rounds of coding after each interview to evaluate the information generated, inter-coder agreement was reached iteratively through group elaborations and discussions. In addition, we reduced the possibility of response bias by ensuring interviewee anonymity and confidentiality. Since we apply a longitudinal qualitative research design, potential observer and sensemaking biases are reduced [108]. Furthermore, continuous discussions with external experts (e.g., former managers, digital hubs) in the field of DT and NPD support the reliability and validity of the qualitative analysis.

### D. Qualitative Results Derived From Case Research

Because we want to gain a deeper understanding of the connection between DT, dynamic capabilities, and NPD performance, the qualitative phase explores which resources, competencies, and capabilities are assessed, possibly reconfigured, and integrated (RQ2). Table VIII summarizes the results of the case studies, presenting the coded categories derived from multiple data sources (e.g., interviews, management presentations, meeting notes, publicly available documents), while Fig. 4 shows the extended model (derived by combining Figs. 1, 3, and Table VIII). In their pursuit of NPD performance, organizations assess, reconfigure, and integrate resources, competencies, and capabilities from different sources. The data structure suggests that organizations focus on VITO dimensions.

*1) Assessing:* Based on the case data, we propose that organizations conduct two major activities during the assessment phase: exploring the pre–DT status quo and designing post–DT scenarios to identify organizations "action potential" [13]. To cope with DT and subsequent change, organizations utilize business model and PEC. They explore how they currently develop products (e.g., NPD process) and what contributes to their value proposition (e.g., business model). While assessing immediate environmental surroundings draws an incomplete picture [30], [37], organizations incorporate not only internal but also external sources of innovation to find promising opportunities [32], [109]. Importantly, during assessing, organizations also identify possible sources of friction, aiming for overall alignment [44], [110]. This dual consideration of how to benefit from sensed opportunities and what to evaluate to avoid tensions (e.g., sensing by seizing [58]) emphasizes that organizations cautiously examine each opportunity not only for its performance potential but also for its disruptiveness (e.g., business model, process logics) to learn for subsequent steps of reconfiguration and integration [27].

When sources of innovation have been scanned, identified, and explored sufficiently, organizations do not directly engage in reconfiguration activities but examine internal and external VITO dimensions to allow "cross-fertilization" [10, p. 891]. The emergent intelligence and information about, for example, who is involved and who needs to be involved, shapes the knowledge, judgment, and interpretation of gaps and boundaries in existing routines and systems. Thus, assessing the status quo and comparing it with the envisioned post–DT state results in various possible scenarios [28] with different strategic implications for business model and NPD process logics [52]. DT requires an out-of-the-box strategy that should focus on emancipating and evolving from the firm's present go-to-market strategies [6], suggesting that copying well-known, established, market-proven strategies in the digital stage bears the risk of failure. Consequently, organizations choose which approach is most suitable for their DT endeavors:

1) iterative and experimental (e.g., learning-based);
2) continuous and incremental (e.g., project-based), or, less frequently;
3) radical and disruptive (e.g., [1], [9], [30], [85], [111]).

*2) Reconfiguring:* After successfully scouting, aligning, and designing scenarios, organizations reconfigure 1) business models, and 2) NPD processes by investing in the opportunities identified depending on their strategic scope [24], [52], [54], [82]. Specifically, disassembling and reassembling existing business model (e.g., business model innovation) and process (e.g., process innovation) logics prepares for the integration of digital technologies (e.g., [10]). Furthermore, because DT is closely linked to the organization-wide introduction, use, and connectivity of digital technologies, a deceptive reconfiguration of resources and capabilities derails existing systems, especially when neither the manufacturing process nor technology, individuals, or organizations are sufficiently prepared, harmonized, and aligned before transformation activities [22], [44].

Organizations are particularly eager to establish a continuous, seamless value conduit, [9], [13] that not only spans internal organizational processes, individuals, technologies, and departments but also includes and (co-)aligns value contributors along the whole value chain (e.g., customers, value partners) under an embedded holistic value umbrella [27], [35].

Following the proposed dimensional logic (i.e., VITO), simultaneous orchestration and co-evolution between dimensions drive the appropriate reconfiguration of resources, competencies, and capabilities for coping with digital technologies and subsequent change. This ultimately creates digital infrastructures, capabilities, responsiveness, and thinking (the second-order themes of Table VIII provide a nonexhaustive list of reconfiguration possibilities).

Extending this observation, business model and PEC are means to reconfigure zero-order capabilities [49] considering the dimensions (i.e., VITO) underpinning previous research, suggesting a hierarchical interaction between higher order and operational capabilities (e.g., [36], [42], [49]). These changes in routines and established systems include outsourcing decisions, especially when anticipated internal barriers are high or digital competencies are not available in the short term but are essential to business operations [22], [30]. Therefore, while assessing accumulates knowledge about tensions, status quo, action potential, and scenarios (pre–DT status quo and designing post–DT scenarios), reconfiguring determines the locus (where?) and area (what?) of DT.

*3) Integrating:* The assessment and reconfiguration of resources, competencies, and capabilities provide organizations with the possibility to integrate explored and exploited digital opportunities, completing the DT journey. Integration allows to enact the change, setting the path for the holistic and embedded usage of digital technologies in digital-centric organizations [16], [84]. Thus, DT requires the integration of digital technologies along the four VITO dimensions (see Table VIII): for example, in business models triggering business model innovation [10], [112], in leadership, strategy, skills, and culture creating a digital mindset [27], [110], in manufacturing and supply chain processes enabling automatization and NPD speed [62], in product offerings expanding market reach and tapping into previously unserved markets [10], in infrastructures for deep and wide anchoring, [8], and in ecosystems to offer connectivity and seamless value creation [16], [113].

Because DT remains a tough endeavor, the integration of digital technologies also relies on the adoption and implementation behaviors of internal and external actors (e.g., employees, customers, suppliers) [22]. Considering that "most revenues derive from traditional products and services" [28, p. 343], many organizations opt to apply incremental, agile, and sequential integration to distinct operational capabilities—namely, iterative and experimental integration (e.g., learning-based) or continuous and incremental integration (e.g., project-based). This is because managing tensions and reaching digital maturity consumes fewer resources and offers the possibility to integrate continuous learning for further changes. Thus, integrating digital solutions that are accessible, usable, and understandable into internal and external organizational routines and systems enables continuous increases in competitiveness and performance [30], [35], [114], [115].

## V. Discussion and Conclusion

The sequential explanatory research design allows us to dive deeper into the phenomenon of DT, business model and PEC, and NPD performance. By combining quantitative (see Fig. 3) and qualitative (see Table VIII) results (see Fig. 4), we gain a richer understanding, offering several possibilities for further discussion and explanations of the consequences of DT to answer our RQs. Therefore, we make theoretical and managerial contributions, aiming to stimulate ongoing academic discussions and spark further research.

### A. Theoretical Implications

First, although there is ample evidence that dynamic capabilities are important for coping with change [26], [46], research on causal paths between DT, dynamic capabilities, and NPD performance remains scant (e.g., [28], [30]). We connect these three constructs to untangle their relationships (e.g., Figs. 3 and 4). In doing so, we quantitatively enrich conceptually or qualitatively derived research models (e.g., [8], [27], [28]). Our model emphasizes that DT requires distinct organizational capabilities (i.e., business model and PEC) that serve as indirect-only mediating variables to establish a causal effect with NPD performance. These findings suggest that reaping performance advantages from digital technologies usually requires altering business model (e.g., business model innovation) or process logics (e.g., efficiency-related innovation). That is, dynamic capabilities are an important coping mechanism for improving NPD performance (e.g., [27], [52]). In addition, we introduce context-specific dimensions (VITO), which we integrate into our tested model (see Fig. 4) to deepen our understanding of the complex interplay of DT and dynamic capabilities. Recent research suggests that an interplay of internal and external contextual dimensions affects dynamic capabilities and competitive advantage [3], [33], [54], [110]; therefore, we underline that DT does not occur in an intra-organizational vacuum. Instead, following the "external-facing" dynamic capability argument of Helfat [32] and drawing on Mele et al.'s [25] work, organizations deploy specific business model and PEC that allow them to transit between internal and external VITO dimensions, scrutinizing digital opportunities and adjusting operational capabilities (e.g., business models, NPD processes). Furthermore, this indicates that external stakeholders constrain the extent to which organizations can realize their DT efforts, effectively serving as a boundary condition that restricts the organization's action potential. Although this may appear counterintuitive [117], there are valid justifications for this assertion. For instance, value creation is increasingly intertwined with ecosystems (e.g., co-creation, open innovation) and should therefore evolve dynamically in sync with the organization's external environment (e.g., partners, stakeholders, suppliers).

Second, the hierarchical perspective broadly categorizes dynamic capabilities into 1) operational capabilities that are essential to routinization and business operations and 2) higher order capabilities that are used to cope with change by extending, modifying, and adapting these operational capabilities (thus, located at a higher level of abstraction) [49]. These higher order capabilities are often difficult to imitate as they are specific to each organization and suited to respond to changing market dynamics [36], [47], [51]. We conceptualize business model and PEC as higher order dynamic capabilities that are used to cope with change as they enable the alteration of organizations' operational lower order capabilities (e.g., business model, NPD process). Our study highlights the contingent theoretical assumption of the hierarchical ordering of dynamic capabilities, underlining that organizations employing higher order capabilities edge competitors that fail to do so themselves [25], [49], [50]. Specifically, we offer a nuanced and sequential view of capability hierarchy because higher order capabilities are means to derive strategic implications for lower order (i.e., operational) capabilities, as underlined by recent research [34], [36], [51].

Third, we provide evidence that when coping with DT, organizations follow three steps consistent with the dynamic-capability view [29], [42]. Specifically, organizations use their higher order (business model and process efficiency) capabilities to derive the necessary competencies and capabilities in the following three steps.

1) Assessing by designing scenarios based on their "action potential" [13], which consists in exploring tensions [44] to determine organizations current maturity in various dimensions (i.e., VITO) shaping their strategic approach.
2) Reconfiguring by orchestrating and coevolving promising digital opportunities along the proposed VITO dimensions to adjust business and process logics based on internal and external accumulated knowledge.
3) Integrating by anchoring these changes broadly and deeply within organizations (e.g., business model innovation), aiming for digital-centricity to enable continuous advantage-building and rising digital maturity levels.

These observations complement Vial's [27], Warner and Wäger's [28], and Ellström et al.'s [30] proposed activities for routinizing DT and advance the existing knowledge highlighting the importance of VITO dimensions serving as boundaries of potential outcomes. Particularly, our contextual dimensions highlight a diverse set of internal and external categories augmenting the factors proposed by Warner and Wäger [28] which focus on triggers, enablers, and barriers.

### *B. Managerial Implications*

Our results can help managers to drive their DT agendas by specifically emphasizing which core competencies and operational capabilities they need to address (see Table VIII). We present a nonexhaustive list that functions as a DT roadmap and taxonomy for managers. Furthermore, we highlight that DT requires new business model and process logics demonstrating that simply transposing well-known systems to the digital landscape is insufficient to derive performance. Especially, incorporating and acknowledging value contributors and facilitating end-to-end thinking (e.g., an internal change affects supplier A, subsequentially affects supplier B, etc.) holds the key to seamless value flows. This underlines the importance of holistic thinking and engaging in ecosystem-building because many individual organizations contribute to overall value which emphasizes not only developing an internal but also an external DT agenda.

Furthermore, we reveal how DT necessitates new approaches to innovation, such as open innovation strategies, collaboration with startups, or the use of data analytics and AI to accumulate appropriate knowledge to successfully assess, reconfigure, and integrate opportunities harnessed from internal and external sources in NPD. Because resources are often restricted and should not be wasted, our study helps to understand that digitally transforming an organization requires a cautious internal and external strategic approach which has implications for strategic planning and resource allocation. By investigating how organizations strategically allocate their resources to support DT initiatives, ensuring that dynamic capabilities are leveraged optimally, managers can optimize resource orchestration in adapting to digital disruptions and exploiting emerging opportunities.

## VI. Limitations and Further Research

This study specifically focuses on business model and process efficiency (dynamic) capabilities to study DT's influence on NPD performance. Nevertheless, it is essential to recognize that there could exist other pertinent capabilities explaining this dynamic. Thus, future research could widen and explore this perspective incorporating additional suitable dynamic capabilities to provide a more comprehensive understanding of this phenomenon. Furthermore, delving into the alignment of intrafirm strategic resources, competencies, and capabilities with the external firm periphery through the theoretical lens of contingency theory can yield valuable insights into the nexus between DT and NPD. Also, we cannot precisely determine the extent of DT's radicality or the optimal level of business model and PEC. Our findings demonstrate positive effects but not the point of potential redundancy (e.g., u-shape or nonmonotonic relationship). Further research is needed to address this issue. Although combining quantitative and qualitative data to provide comprehensive results, we did not support qualitative findings with quantitative-grounded analysis (e.g., interactions between dynamic capabilities and their internal and external (VITO) dimensions; see Fig. 4), and thus, our understanding is limited.

From a methodological perspective, we cannot describe any observations between time intervals and how two time-separated observations may differ or remain equal. Thus, further research could consist of longitudinal studies using a multioccasion lens with several (temporally distributed) measurements. By using a multiple (longitudinal) case study, we analyzed data from various experts in the field of DT. However, the accuracy of this data could suffer from individual perception bias. Although we followed the common practice of consulting experts in survey-based studies, another limitation comes from the selection of a single respondent per firm. To counteract this limitation, forthcoming research endeavors should encompass multiple respondents from each organization, enabling a more comprehensive encapsulation of the multifaceted landscape of knowledge. Finally, applying a mixed method design (e.g., sequential explanatory approach) causes tensions that lead to sacrifices to balance the readability, flow, and transparency of each methodology (quantitative and qualitative). Hence, more qualitative, or quantitative studies, focusing on specific aspects within this triad, are essential to bolster the rationale presented in this study.

## APPENDIX I
## VARIABLES AND CONSTITUENT ITEMS, INCLUDING RELIABILITY AND VALIDITY INFORMATION

| Variable | Items | Sig. | Load. | VIF |
|---|---|---|---|---|
| Digital transformation α = 0.92; CR = 0.91 Nasiri et al. [62], Aral and Weill [94] | 1. We aim to digitalize everything that can be digitalized (e.g., process, product development) | 14.470 | 0.763 | 1.899 |
| | 2. We create more robust networking with digital technologies between the different business processes | 21.648 | 0.843 | 2.944 |
| | 3. Our business operations shift toward making use of digital technologies | 11.815 | 0.702 | 3.823 |
| | 4. We integrate digital technologies to drive change | 15.243 | 0.782 | 4.281 |
| | 5. We drive new business processes and logics built on digital technologies | 28.180 | 0.915 | 3.783 |
| Business model capabilities α = 0.88; CR = 0.90 Ferreras-Méndez et al. [2], Guo et al. [81] | 6. We regularly change the way in which we provide value to our customers | 24.024 | 0.819 | 1.679 |
| | 7. We regularly look for new sales strategies to generate revenues | 17.920 | 0.763 | 2.370 |
| | 8. We experiment with new business models in our markets | 22.940 | 0.808 | 2.391 |
| | 9. We regularly use new distribution and sales channels | 18.757 | 0.785 | 2.386 |
| | 10. We often change the cost structure (fixed and variable costs) within our organization | 13.251 | 0.681 | 1.848 |
| | 11. We frequently change and adjust our business model based on innovations and new ideas | 18.737 | 0.798 | 2.011 |
| Process efficiency capabilities α = 0.89; CR = 0.91 Chen et al. [70]; Schweitzer et al. [95] | 12. The time-to-market of our organization's new products is short | 34.992 | 0.867 | 2.131 |
| | 13. Our products are developed and launched faster than those of our major competitors | 37.468 | 0.925 | 2.839 |
| | 14. Our products are launched in less time than what is considered normal in the industry | 15.930 | 0.751 | 2.670 |
| | 15. Our products are launched on (or ahead) of the original schedule | 21.856 | 0.824 | 2.341 |
| New product development performance α = 0.89; CR = 0.89 Ferreras-Méndez et al. [2], Acur et al. [73] | 16. From an overall profitability standpoint, our newly developed products are successful | 27.686 | 0.887 | 2.374 |
| | 17. Compared with our major competitors, our newly developed products are more successful | 23.831 | 0.873 | 1.934 |
| | 18. The overall performance of our newly developed products has met our objectives | 13.556 | 0.691 | 2.311 |
| | 19. Our new products meet customer requirements | 11.098 | 0.588 | 2.241 |
| | 20. The impact of our newly developed products on our sales level is positive | 20.732 | 0.816 | 2.628 |

Note: We use seven - point Likert - type scales (i.e., 1 = strongly disagree to 7 = strongly agree) to score each indicator. None of the indicators fulfills all requirements for deletion, that is, not-significant indicator weight and indicator loading below 0.500 (all indicator loadings are above 0.500) and not-significant indicator loading (all indicator loadings are significant). Therefore, we decided against dropping any indicator as suggested by the decision-making process proposed by Hair et al. [38]. This is because any dropped indicator may influence its construct's and the measurement model's content validity. α (Cronbach's alpha) with values above 0.700 considered sufficient; CR = composite reliability; Sig. = $t$-statistic of the indicator loadings; Load. = indicator loadings; VIF = variance inflation factor with values below 5 considered sufficient.

## APPENDIX II
## EVALUATION OF OUR CASE STUDY TO INCREASE CASE RESEARCH QUALITY, ADAPTED FROM GOFFIN ET AL. [106]

| Category | Evaluation criteria | Application |
|---|---|---|
| Research design | Theoretical foundation | The adoption of the case method is appropriate because it provides a finer-grained and deeper problematization of our quantitative results. Therefore, the case method is important in drawing our conclusions. |
| | Pilot study | Given that our case study protocol includes a pilot study and an expert assessment, we were able to review and revise our interview questions and derive comprehensive interview guidelines. Thus, before collecting our case data, valuable insights, comments, and remarks were incorporated. |
| | Theoretical sampling | The cases were selected based on an ideal case profile developed from an expert assessment. Additionally, the cases reflect the industries in the quantitative study and represent established organizations. |
| Data collection | Triangulation | This study uses several different cross-case data sources: (i) interviews, (ii) internal case data (e.g., management presentations, meeting notes), and (iii) publicly available documents. |
| | Review/ validation of evidence | Our multiple longitudinal case study design includes an interviewee-feedback session in the second round of interviews, which serves as a validation mechanism. Furthermore, we compared our case evidence with the existing literature. |
| | Transparency of data collection | We present the themes covered by our interview questions and case details. The semi-structured interviews moved from open-ended questions to precise questions adapted to the interviewees' responses. In addition to recording and transcribing the interviews, we took handwritten notes. |
| Data analysis | Inter-coder agreement | Conducting group sessions to discuss the information gathered after each interview allowed us to compare and resolve differences in perceptions to reach a common understanding. |
| | Case presentation | We derive a data structure from the analysis of the collected data. The application of an open-coding technique and the presentation of in-vivo interviewee quotes ensures comprehensibility. Furthermore, we use several visualizations and additional case quotes to support our reasoning (e.g., trail of evidence). Thus, we explicitly illustrate how we obtain our results. |
| | Case interpretation | To move beyond a descriptive state, we derive conceptual significance of the results of the case study by extracting and discussing them with the existing literature and leveraging them to enrich the results of our quantitative structural model. |
| Post-hoc | Reflecting on validity and reliability | Since we ensure the anonymity and confidentiality of the interviewees and engage in continuous discussions with experts, we increase the reliability and validity of our qualitative analysis. Furthermore, potential limitations are addressed. |

## Appendix III
## Description and Details of Selected Cases

| Case | Nr. of inter-views | Indus-try | Size | Re-venues (mUSD) | Description |
|---|---|---|---|---|---|
| A | (2) business develop-ment manager (2) product manager | Health-care | >10 000 | 10 000–15 000 | "A" is a medical technology and device company dating back to the mid-19th century. "A" focuses on patient-centric medical innovations and products serving its customers globally in over seventy locations. "A" describes innovation and digital technologies as its core values, strongly focusing on digital transformation in the healthcare industry. |
| B | (2) inno-vation and digital trans-for-mation manager | Con-struc-tion | 1000-10 000 | 500–1000 | "B," founded in the 19th century, produces building materials (e.g., asphalt, concrete) for the construction industry. The company operates internationally and owns more than 300 plants. "B" launched several digital transformation initiatives and projects to explore and exploit digital technologies. |
| C | (2) business develop-ment manager (2) product manager | Health-care | >10 000 | 10 000–15 000 | "A" is a medical technology and device company dating back to the mid-19th century. "A" focuses on patient-centric medical innovations and products serving its customers globally in over seventy locations. "A" describes innovation and digital technologies as its core values, strongly focusing on digital transformation in the healthcare industry. |
| D | (2) digital trans-for-mation manager | Phar-maceu-ticals | >10 000 | 25 000–50 000 | "D" is a globally operating biotechnology and pharmaceutical corporation with over 150 years of experience. "D" has a strong worldwide market presence and is among the leading companies in its fields. It offers innovative products and solutions to its customers, aiming to sustain its current market-leading position. |

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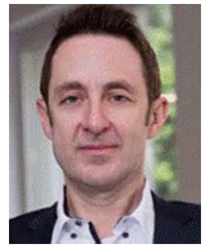

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