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# Building Capacity for Digital Transformation: Strategic Priorities and Gaps in the Pharmaceutical Ecosystem

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## Abstract

This study explores how actors in ecosystems shaped by non-digital incumbents with legacy business models build the capacities required for digital transformation, using the pharmaceutical industry as a case in point. As the pharmaceutical business model is tightly interwoven and rooted in a pre-digital era, transformation efforts depend on the coordinated development of capacities that extend beyond their traditional core. While previous research has largely focused on individual organizations, it has often neglected the ecosystem perspective – which is particularly relevant for digital transformation, where a wide range of actors must coordinate across boundaries. To address this gap, we identify five capacity dimensions in the literature and contextualize how they are prioritized, interrelated, and shared across the ecosystem over time. Our findings reveal that although pharma is a well-established ecosystem with collaborative structures, digital transformation remains largely an actor-level effort: Technical and operational aspects are addressed early on but mostly lack cross-actor integration, regulatory and financial capacity follow selectively, and organizational capacity is addressed last, if at all. These patterns reflect the absence of structured collaboration at the ecosystem level, with partnerships often transactional and driven by short-term needs. The study contributes by identifying a boundary to ecosystem theory, showing that collaborative capacity building for digital transformation does not naturally emerge in historically non-digital environments. Practical implications include entry points for coordination and integration through internal roles, intermediary platforms, shared benchmarks, and holistic planning approaches.

**Keywords:** Ecosystem Theory, Capacity Building, Digital Transformation, Pharma, Qualitative Research

# 1. Introduction

For established organizations with pre-digital business models – often referred to as non-digital incumbents – digital transformation requires building new capacity: resources, structures, and processes that extend beyond their traditional core (Christensen, 1997; Hanelt et al., 2021; Karimi & and Walter, 2015). This challenge is particularly pronounced in mature and interconnected sectors such as pharmaceuticals, where a wide range of actors must align to deliver global healthcare (Christensen & Karlsson, 2019). In such settings, many of the benefits associated with digital transformation can only be realized through cross-actor collaboration, leading recent research to highlight the relevance of an ecosystem perspective (Chen et al., 2022; Rettig & Vanhaverbeke, 2024).

Ecosystem theory positions innovation – and thus transformation – as inherently collaborative, involving loosely coupled yet interdependent actors who contribute complementary resources to create shared value (Adner, 2017; Granstrand & Holgersson, 2020; Jacobides et al., 2018; Moore, 2006). Following this logic, successful digital transformation would prompt a naturally emergent collaborative process, enabling actors to jointly build the capacities needed for systemic change. However, how such capacity building unfolds in practice, and whether it can be effectively coordinated across the ecosystem, remains an open question (Baldwin et al., 2024).

To examine whether such coordination occurs in practice, this paper investigates how capacity building unfolds in the pharmaceutical sector – an ecosystem organized around non-digital incumbents and currently undergoing digital transformation. We approach this question through the lens of capacity building, as it offers a perspective for understanding how transformation-relevant capacities are developed, aligned, and sustained across actors.

## 1.1 Capacity Building in the context of Ecosytems

Capacity building is an interdisciplinary concept that refers to the processes through which individuals, organizations, or communities acquire, strengthen, and sustain the capacities needed to achieve specific goals (Brown et al., 2001). As opposed to individual capabilities that describe what a system is able to do, capacities refer to the enabling resources and structural conditions that must be developed in order to make transformation possible (Venner, 2015). This includes not only the resources as such, but also the strategic ability to deploy them effectively in support of innovation and coordination (Kastelli et al., 2024).

What makes capacity building a particularly suitable lens for analyzing digital transformation in business ecosystems, especially in the pharmaceutical sector, is a combination of three features: its origin in institutional environments, its perspective on systematic change involving interdependent actors, and its focus on structural preconditions for joint action – an aspect that remains underexplored in most adjacent theories.

First, capacity building emerged in fields such as public health, development, and education, where actors operate under regulatory influence and limited control over system boundaries (Ostrom, 1990; Sen, 1985). These early applications were designed to enhance the ability of communities or institutions to navigate distributed responsibilities and constraint – challenges that also characterize business ecosystems (Gomes et al., 2018; Tsujimoto et al., 2018). More recently, these foundational ideas have been revisited in digital public sector contexts, where capacity building must respond to both institutional complexity and technological disruption (Nurdin & Purna, 2023).

Second, capacity building offers a system-oriented understanding of transformation. It builds on early organizational learning approaches that emphasized systems thinking and adaptation within organizations (Argote, 2012; Senge, 1990). These insights continue to resonate in the context of digital transformation, where agile learning and cross-functional coordination have become central to collective adaptation (Warner & Wäger, 2019). From a capacity-building perspective, such dynamics underscore the importance of conditions under which collective structures become capable of coordinated action (Klinsky & Sagar, 2022). This includes the development of shared frames of reference through sensegiving, the scripting and alignment of actor roles, and structural orchestration mechanisms that stabilize cooperation (Boons & Spekkink, 2012; Schepis et al., 2021; Tabas et al., 2023). Such dynamics are particularly relevant in ecosystems, where transformation depends not only on individual agency, but on the ability of actors to contribute to a loosely coordinated whole (Basole et al., 2015).

Third, capacity building engages with adjacent theoretical traditions that have shaped how we understand transformation: the resource-based view, the knowledge-based theory of the firm, dynamic capabilities, and absorptive capacity. Collectively, they have emphasized different dimensions of strategic action – from asset orchestration and organizational learning to adaptability and knowledge integration (Barney, 1991; Cohen & Levinthal, 1990; Grant, 1996; Teece, 2007). Over time, these theories have evolved toward more relational, distributed, and interorganizational perspectives (Chatterjee et al., 2022; Corbo et al., 2023; Nayak et al., 2023; Pitelis et al., 2024; Sandberg et al., 2021; Zahra, 2021), yet often remain focused on specific functions within or between firms. While these theoretical developments reflect a growing awareness of complexity, they still tend to emphasize specific firm-level mechanisms – such as learning, adaptation, or resource orchestration – and pay less attention to the systemic conditions for coordinated transformation. Capacity building offers a complementary lens: rather than concentrating on one type of strategic capability, it foregrounds the structural and institutional conditions under which collective transformation becomes possible. In doing so, it shifts the analytical focus from isolated actors and internal competencies to the system-level capacities that enable coordinated change.

The following section draws on this perspective to specify the capacity dimensions most relevant for digital transformation in ecosystems centered around non-digital incumbents.

### 1.2 Dimensions of Capacity Building for Digital Transformation

Digital transformation refers to the profound and systemic integration of digital technologies into all areas of an organization, fundamentally changing how it creates, delivers, and captures value (Vial, 2019). Its strategic impetus lies in enhancing business value, fostering innovation, and increasing organizational agility in response to competitive environments (Hess et al., 2016). Rather than a purely technological shift, digital transformation is widely understood as a multi-stage process of complex organizational change, in which each phase places distinct demands on priorities, resources, and capabilities (Matt et al., 2015; Parviainen et al., 2017).

These demands are particularly pronounced in ecosystems built around non-digital incumbents whose core business models were shaped in pre-digital eras (Hanelt et al., 2021; Karimi & and Walter, 2015). In such settings, digital transformation unfolds under specific structural conditions, including the presence of legacy systems, siloed organizational architectures, and a limited availability of digital expertise (Chanias et al., 2019). These are often accompanied by established strategic priorities and an inherent tension between maintaining operational efficiency and pursuing innovation (Christensen, 1997; Jesus et al., 2024).

While existing literature has identified a broad range of drivers for digital transformation and acknowledges the relevance of strategic alignment of organizational resources (Osmundsen et al., 2018; Tangwaragorn et al., 2024), it leaves open important questions about the systemic capacities needed to navigate transformation in multi-actor settings: Nadkarni and Prügl (2021) emphasize the need to investigate how diverse actors can build the capacity to act and interact effectively in digitally transforming environments. Similarly, Kraus et al. (2021) highlight a lack of contextualization with regard to specific industries – particularly those marked by inter-organizational dependencies that are characteristic of ecosystems.

Responding to these gaps, we propose a structured framework to support a more differentiated understanding of transformation prerequisites in ecosystems organized around non-digital incumbents. At its core, this framework consists of five dimensions that reflect the systemic conditions under which digital transformation becomes possible, and are derived from the key theoretical strands outlined above: capacity building, digital transformation, and the ecosystem perspective.

- *Technical capacity* refers to the ability to integrate and manage advanced digital technologies such as AI, IoT, and big data analytics. Effective capacity building requires a solid understanding of technological principles and developing the competencies needed to apply digital tools effectively – both within organizations and across ecosystem interfaces (Favoretto et al., 2022; Rybski & Jochem, 2016).
- *Operational capacity* involves optimizing processes and infrastructure to support digital integration. This includes improving efficiency and ensuring adaptability to evolving conditions, as well as to interorganizational coordination needs (Butt, 2020; Kretschmer & Khashabi, 2020; Stentoft et al., 2021).
- *Regulatory capacity* describes the ability of organizations and institutions to co-shape regulatory frameworks in response to digital innovation. Especially in highly regulated fields such as pharmaceuticals, this involves developing expertise in digital compliance, data governance, and shared standard-setting across ecosystem actors (Chen et al., 2022; Ganesh et al., 2020).
- *Financial capacity* captures the availability and strategic allocation of financial resources to support long-term transformation initiatives. This includes investments in digital infrastructure, financing models for ecosystem-wide innovation, and risk-sharing mechanisms under uncertainty (Luo, 2022; Matt et al., 2015).
- *Organizational capacity* encompasses leadership, culture, and change management needed to foster digital readiness. It includes the ability to overcome cultural resistance, enable cross-actor collaboration, and align digital transformation with long-term, shared strategic goals (Butt et al., 2024; Hanelt et al., 2021; Imran et al., 2021).

### 1.3 Literature Synthesis and Research Focus.

Based on the preceding literature analysis, this study is grounded in the assumption that an ecosystem perspective is appropriate for analyzing digital transformation in the pharmaceutical sector. Prior research in both digital transformation and ecosystem studies emphasizes that transformation succeeds when it is approached as a system-level endeavor – requiring coordination and collaboration across organizational boundaries.

Against this background, it is plausible to expect that the development of transformation-relevant capacities would occur in a coordinated or even spontaneous manner across actors, particularly given that the pharmaceutical sector – while shaped by non-digital incumbents –

is already organized around established ecosystem structures and mechanisms. Furthermore, digital transformation is widely understood as a multi-stage process of complex organizational adaptation. It can therefore be assumed that capacity development unfolds in phases and follows a temporal logic that is shaped by shifting transformation needs.

However, while the literature points to the relevance of multiple capacity dimensions, it remains unclear how these capacities can be developed, prioritized, and coordinated across ecosystem actors during the transformation process. To address this gap, we identified capacity building as a suitable analytical lens to examine how digital transformation unfolds across actors in ecosystems of non-digital incumbents. Based on this conceptual approach, the five core dimensions derived from the literature guide the empirical analysis of this study, as outlined in the following section.

## 2. Methodology

### 2.1 Research Design and Data Collection

As this study enters the field with a concrete theoretical expectation of collaborative capacity building across the ecosystem, yet remains open to how such processes unfold in practice, it adopts an abductive, qualitative research design. A qualitative approach is particularly suited to explore how capacity building for digital transformation actually materializes beyond organizational boundaries, often in ways that are relational and non-linear. Such patterns typically elude quantitative instruments but require interpretive engagement with the perspectives of ecosystem actors (Bell et al., 2022). Similarly, abductive reasoning allows for theoretical assumptions to be connected with unexpected empirical observations, helping to integrate conceptual frameworks and practical realities (Timmermans & Tavory, 2012).

To explore these dynamics, empirical insights were generated through semi-structured interviews with 20 senior representatives of pharmaceutical companies, contract manufacturers, suppliers, technology providers, and industry associations. Participants were selected for their active involvement in digital transformation initiatives, with attention to capturing diverse roles and perspectives across the ecosystem. Interviews were conducted remotely between July and December 2024 via Microsoft Teams, with Copilot used to support automated transcription. Transcripts were refined and paraphrased for analytical clarity, then returned to participants for review and minor corrections (Lincoln & Guba, 1985). Data collection received approval from an independent ethics committee and complies with EU data protection laws. Particular care was taken to ensure anonymity and interpretive fairness throughout the research process, especially given the strategic sensitivity of the topic.

### 2.2 Analytical Strategy and Coding Framework

The analysis was guided by a coding framework that operationalized the five capacity dimensions central to this study: technical, operational, regulatory, financial, and organizational. Each dimension was defined by observable indicators and linked to analytical questions derived from the theoretical model. While this structure provided conceptual grounding, the coding process remained flexible and abductive, allowing space for patterns that emerged across actor roles, phases of transformation, and ecosystem layers. Table 1 summarizes how the five capacity dimensions were operationalized and used as an analytical lens.

Particular attention was paid to how actors prioritized different capacities under strategic pressure, how these capacities interacted across organizational boundaries, and how their relevance shifted over time. This focus on prioritization, interdependencies, and sequencing was especially relevant in the pharmaceutical sector, where digital transformation unfolds within a legacy environment. The coding was supported by NVivo software, and ChatGPT was used to improve the clarity and flow of the writing. All software tools were used to support – but not replace – analytical judgement.

Based on this analytical lens, the following empirical section explores how these capacity dimensions materialize across the pharmaceutical ecosystem.

*Table 1: Coding framework for analyzing ecosystem-wide capacity building dynamics*

| Capacity Dimension | Focus of Analysis / Sample Indicators | Analytical Guiding Questions |
|---|---|---|
| **Technical Capacity** | Mentions of AI, platforms, data integration, legacy systems, technical competencies, interoperability, shared infrastructure | • How do actors describe their ability to adopt and apply digital technologies?<br>• Are technical capacities built internally or in collaboration with ecosystem partners?<br>• When does technical capacity become a strategic priority, and how is it shared or scaled across the ecosystem? |
| **Operational Capacity** | References to workflows, process redesign, cross-actor coordination, ecosystem-level operations, scalability, infrastructure readiness | • How are internal processes adapted to support transformation?<br>• How is operational capacity coordinated or dependent across actors?<br>• At what stages is it critical, and how does it enable or delay other capacities? |
| **Regulatory Capacity** | Statements on compliance, interpretation of regulations, regulatory alignment, data governance, standard-setting participation | • How do actors interpret and navigate evolving regulation?<br>• How is regulatory capacity aligned or negotiated across the ecosystem?<br>• How does it influence or reflect technical and organizational readiness over time? |
| **Financial Capacity** | Comments on digital investment, resource allocation, joint funding models, cost-benefit trade-offs, risk-sharing mechanisms | • How are digital initiatives financed and justified?<br>• How do funding strategies depend on ecosystem collaboration or reflect strategic divergence?<br>• When is financial capacity mobilized, and how does it enable or constrain transformation? |
| **Organizational Capacity** | Discussion of leadership, culture, resistance, shared strategic vision, cross-level collaboration, ecosystem alignment | • How do leadership, culture, and collaboration shape readiness for change?<br>• Are transformation goals jointly defined, and how is organizational alignment achieved across actors?<br>• When does organizational capacity become decisive, and how does it support or limit other capacities? |

*Source: Own representation*

Building on this analytical structure, a final interpretive step was conducted to derive practice-oriented implications. This involved synthesizing observed patterns into practical mechanisms through triangulation between empirical data, theoretical framing, and contextual reasoning. The resulting recommendations reflect both the coded findings and the structural tensions that emerged during analysis, which are further elaborated in the concluding section.

## 3. Results

The empirical findings reveal a sequential but fragmented pattern of capacity development across the pharmaceutical ecosystem. The following section delves into each capacity dimension in detail, highlighting how these dynamics unfold and what alignments or tensions emerged from the data.

*Technical capacity* is developing actively but unevenly across the ecosystem. Some actors deploy advanced applications such as real-time monitoring, AI-supported simulations, and integrated platform strategies, while others still rely on fragmented IT infrastructures or even paper-based documentation. Digital tools are often introduced faster than they can be meaningfully embedded into existing workflows and systems, prompting them to remain in a pilot stage. Tensions between centralized architectures and local requirements are common, and legacy systems or missing standards frequently limit scalability. Despite these constraints, technical innovation is progressing – sometimes through pragmatic workarounds such as parallel infrastructures. Data quality and interoperability are widely seen as critical enablers for moving from isolated tools to systemic transformation.

*Operational capacity* follows suit to technical capacity but remains delayed by internal fragmentation in many parts of the ecosystem. Actors are often preoccupied with aligning their own, historically grown business processes, which limits the ability to coordinate workflows across the ecosystem. In the absence of clear ecosystem governance, operational workflows tend to evolve reactively, shaped more by resource constraints than by strategic redesign. Still, selected cases demonstrate that collaborative development and cross-functional rollouts can foster operational maturity and mutual learning. Where process models exist, they typically require local adaptation, resulting in hybrid implementations under central frameworks.

*Regulatory capacity* develops cautiously and often remains detached from technical and operational advances. Compliance frameworks are otherwise well established in pharmaceuticals, yet this regulatory logic is rarely synchronized with digital transformation trajectories. Interpretations of what is required vary widely across actors, and structural inequalities further hinder capacity development, especially for smaller actors with limited access to institutional support. At the same time, selected initiatives point toward more proactive approaches: in those cases, standard-setting is pursued collaboratively to ensure both technical feasibility and regulatory alignment.

*Financial capacity* tends to follow short-term rationales and remains largely tied to project-based initiatives. While this allows for targeted experimentation, it often prevents actors from addressing infrastructure needs or aligning investments with long-term transformation goals. Smaller actors face particular challenges, as limited funding and know-how restrict their ability to engage in digital transformation at scale. Still, there are signs of emerging financial coordination: in selected cases, co-financing arrangements are used to align interests across ecosystem partners and distribute investment risks more evenly.

*Organizational capacity* emerged as the final dimension to be addressed in transformation efforts. Structures for cross-organizational exchange exist and could facilitate collaborative learning, yet are rarely activated early or strategically. In many cases, organizational questions are treated as secondary to technical implementation or regulatory compliance. Fragmented responsibilities and missing ownership further complicate coordination across both, internal units and organizational boundaries. Moreover, the development of digital skills varies significantly between actors, often depending on size and available resources. As a result, ecosystem readiness is seldom built from the outset and tends to follow rather than drive structural change.

*Cross-cutting patterns* emerged in the data as an additional layer shaping how ecosystem actors generally approach capacity building. Centralized, decentralized and hybrid models coexist – sometimes even within a single organization – without consistent alignment to actor types or transformation profiles. Despite a strong will to collaborate and a shared understanding that ecosystem-wide efforts would be beneficial, cooperation occurs selectively – most often in non-competitive areas such as regulatory harmonization. Strategic or differentiating developments, including data architectures or proprietary tools, are deliberately pursued within organizational boundaries. Ecosystem-wide initiatives exist, but remain limited in scope and loosely connected to organizational capacity-building efforts.

Table 2 provides an overview of key patterns and illustrative quotes associated with each capacity dimension.

Building on these findings, the following chapter examines how they challenge existing theoretical assumptions and what they imply for coordinated capacity development in incumbent ecosystem settings.

*Table 2: Matrix display of key patterns and illustrative quotes across five capacity dimensions*

| Capacity Dimension | Observed Patterns | Description | Illustrative Quotes and Interview ID |
|---|---|---|---|
| **Technical Capacity** | Advanced use cases | Use cases such as digital twins, AI-supported monitoring, and model-based design as indicators of technical maturity | "Previously, we might have conducted 50–60 small-scale experiments to explore process parameters impacting quality attributes. With a calibrated model, you can transfer knowledge across processes and reduce experimental workload by 30–50 %." (IP17) |
| | Fragmented landscape | Systems and tools are introduced rapidly but often lack system integration | "With other systems, like those for maintenance, or even topics like the Metaverse and Omniverse, things get complicated. […] You start wondering how to integrate all of it meaningfully, without overlaps or redundant solutions." (IP19) |
| | Data quality gap | Poor data structure limits adoption and scalability | "It's clear: Garbage in, garbage out. If the data isn't well structured and classified, the output is nonsense." (IP18) |
| | Pragmatic workarounds | Parallel systems avoid friction with existing IT infrastructure | "We just run the system separately. That way, we don't need a validation concept, because it doesn't interfere with production control." (IP17) |
| **Operational Capacity** | Process complexity | Fragmented internal structures and unclear process responsibilities hinder cross-organizational alignment | "We are facing the major challenge that even this very first point – our internal business processes – lacks transparency." (IP06) |
| | Joint development | Co-development processes foster operational maturity and mutual learning | „[…] it's an iterative process. We define the framework, the partners start with development, and then new questions arise that we clarify together." (IP01) |
| | Central vs. local | Structured standardization allows for local adaptation | "We ensured 80% of the solution was standardized and consistent, while allowing up to 20% customization. This gave countries a sense of ownership and ensured their unique needs were met." (IP06) |
| | Reactive adjustments | Stabilizing routines delay change; adjustments rather occur when problems arise | "If the existing system works and inspectors haven't raised concerns, the general rule is: 'Don't touch a running system." (IP09) |
| **Regulatory Capacity** | Regulatory misalignment | Compliance focus overrides capacity-building efforts; temporal mismatch between innovation and regulation due to varying interpretations of requirements | "You want to get started – but the existing regulations simply don't match the current state of technology." (IP20) |
| | Joint standards | Shared standardization supports mutual understanding and lays the groundwork for regulatory coordination. | "A particularly effective lever – maybe even the decisive one – would be standardization […]. If such standards are anchored in norms like ISO or DIN, everyone would have to comply." (IP06) |
| | Structural disadvantages | Small actors struggle to meet regulatory demands | "It is important that machine manufacturers are also heard, so that the standards remain technically feasible and economically viable. There's no point in creating standards that can't be implemented in practice – or that are too demanding in terms of capacity." (IP20) |
| **Financial Capacity** | Project-based financing / Lack of strategic invest | Competing budget priorities often restrict funding to isolated projects, limiting strategic investment | "But such innovations quickly reach their limits when budgets tighten. Pharma companies have to choose where to invest – in biotech startups, R&D, or digitalization." (IP10) |
| | Co-financing models | Joint financing strategies align interests across ecosystem actors | "Of course, the whole thing came with conditions: anyone who wanted to participate had to pay for the service through a subscription model or fees. That's how such models emerge – where all participants benefit, but everyone also has to contribute." (IP18) |
| | Unequal funding | Resource asymmetries limit | "There are many partnerships between pharmaceutical |

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|---|---|---|---|
| | access | participation in digital innovation | companies and DTx [digital therapeutics] providers, who often specialize in particular diseases. In the first wave, many [of these] startups tried to succeed with B2C business models – but they soon realized that the path to refinancing is extremely long and difficult." (IP10) |
| **Organizational Capacity** | Low prioritization | Organizational aspects are addressed reactively and with low strategic visibility | "But the importance of the topic is usually only sporadically perceived by top management – CEOs or other leadership positions." (IP09) |
| | Coordination gap | Coordination lacks anchoring and responsibility, hindering both internal and cross-actor alignment | "Another issue is responsibility. Sometimes digitalization is seen as an IT topic, sometimes as a production topic. Often, it's unclear who's actually in charge – which further complicates collaboration." (IP01) |
| | Uneven skillsets | Skills building varies by actor size and maturity, but also internally | "Professionals who understand both IT and production processes are rare. In our unit, we have only a few people who combine these skills. If they leave, we face major challenges." (IP01) |
| | Learning structures | Shared formats and associations could foster collaboration and knowledge exchange | "Organizations like PDA or ISPE probably have the most active formats in this space, with their working groups and committees." (IP09) |
| **Cross-cutting patterns** | Lack of ecosystem-wide collaboration | Despite shared challenges, cross-actor collaboration rarely occurs beyond compliance. | "In my view, collaboration in the pharmaceutical industry [in terms of digital transformation] doesn't represent a functioning ecosystem. Companies largely operate in isolation. […] Genuine exchange rarely occurs." (IP07) |
| | Collaborative ambition | Cross-actor collaboration for digital transformation is perceived as beneficial | "There is a shift happening in the industry. Pharma companies are increasingly realizing that they cannot collect enough data on their own to solve complex problems. That creates a certain openness to collaboration. […] It's a step in the right direction when companies start to realize that they must work together to make real progress – especially for the benefit of patients." (IP07) |
| | Strategic separation | Differentiating developments like data architectures are deliberately kept within organizational boundaries. | "One problem is that many suppliers want to protect their proprietary data formats in order to sell their licenses and systems more effectively. This leads to significant fragmentation." (IP09) |
| | Loosely connected initiatives | Cross-actor initiatives remain limited and fail to scale across the ecosystem. | "It's highly fragmented. Everyone is trying to build their own platforms with different vendors." (IP19) |

*Source: Own representation*

## 4. Discussion & Conclusion

The empirical findings highlight a central paradox: Although the pharmaceutical sector operates within long-established ecosystem structures, capacity development for digital transformation remains an actor-level effort. Cooperation is seen as beneficial and occurs in selected areas, but there is no shared trajectory or ecosystem-wide alignment. Strategic approaches vary widely and show no consistent pattern across actor types. These observations raise important questions about the limitations of coordinated transformation and offer insights into the theoretical assumptions outlined in Chapter 1.3 – both of which are further explored below.

### 4.1 Theoretical Reflection

First, the ecosystem perspective proved analytically appropriate and empirically resonant. Across interviews, actors emphasized that digital transformation in the pharmaceutical sector cannot succeed through isolated efforts. Instead, they highlighted a shared understanding that sustained progress requires cross-actor collaboration and system-wide coordination. This confirms that the challenges of digital transformation are not merely intra-organizational but inherently ecosystemic, validating the decision to frame the study at this level of analysis (Adner, 2017; Jacobides et al., 2018).

However, the expectation that interdependence – especially in ecosystems with established collaborative structures – would naturally lead to coordinated capacity building for digital transformation was not confirmed by the empirical data. This challenges early assumptions about the self-organizing nature of ecosystems (Moore, 2006) and highlights the limits of structural interdependence as a driver of alignment (Adner, 2017). In mature ecosystems dominated by non-digital incumbents, institutional logics and path dependencies seemingly shape behavior more strongly than relational interdependencies – a dynamic that ecosystem theory has so far insufficiently addressed. Hence, successful capacity building in digitally transforming ecosystems may require deliberate orchestration.

A related assumption concerned the temporal logic of capacity building. The analysis confirmed that digital transformation often triggers a phased build-up of capacities – with technical and operational aspects addressed early, regulatory and financial dimensions following selectively, and organizational capacity addressed last, if at all. However, these phases unfolded asynchronously across actors and remained disconnected, both temporally and strategically. As a result, cross-actor coordination was limited, and the systemic momentum that theories of organizational learning and adaptation would predict failed to materialize (Argote, 2012; Matt et al., 2015; Parviainen et al., 2017; Senge, 1990).

Finally, the conceptual lens of capacity building proved analytically robust and well-suited to the scope of this study. It allowed for systematically tracing <u>how</u> capacity dimensions were prioritized, developed, and distributed across the ecosystem. Theoretically, this framework would also provide explanations for <u>why</u> capacity-building efforts may fail – such as a lack of resources or strategic priority. Yet, the data offer initial indications that more deeply rooted institutional dynamics may play a role, particularly given that the pharmaceutical ecosystem otherwise functions in a highly regulated manner. Future research should therefore complement capacity building with institutional or governance perspectives to better understand the constraints of ecosystem-wide transformation.

### 4.2 Implications for Practitioners

Among the theoretical insights, two tensions stand out as particularly relevant for practice: first, coordination does not emerge naturally among interdependent actors, highlighting the need for explicit mechanisms to align capacities across boundaries; and second, capacity development tends to unfold in phases, which calls for planning efforts that support integrated progression. Addressing these tensions involves both deliberate measures within actor organizations and shared approaches at the ecosystem level. In response, we outline four practical mechanisms – two for each tension and level – that suggest practical entry points for more collectively grounded capacity-building.

#### 4.2.1 Coordinating capacity building among interdependent actors

A central challenge concerns the lack of designated responsibility for ecosystem-wide coordination. While structural interdependencies are widely acknowledged, few actors are equipped with roles or mandates to translate these into aligned action. Two complementary mechanisms can support this: internal coordination roles and intermediary platforms that structure collaboration beyond organizational boundaries.

*Internal coordination roles:* Actors can establish internal roles that help link individual initiatives to collective capacity-building efforts. In digitally native ecosystems, specialized functions such as ecosystem coordinators have emerged to encourage alignment and collaborative learning (Gomes et al., 2022; Tabas et al., 2023). Such roles could be further developed in regulated environments to make interdependencies visible and coordinate phased implementation. They may take the form of transformation leads, cross-functional integration managers, or liaison officers who represent organizational efforts in broader ecosystem initiatives. Positioned at the intersection of operational and strategic domains, these roles can ensure that internal developments remain responsive to external shifts, while also translating ecosystem-level priorities into actionable roadmaps. Establishing such roles requires clear mandates and strategic support, but can ultimately reduce fragmentation in capacity-building efforts.

*Intermediary platforms:* At the ecosystem level, neutral intermediaries can complement internal efforts by structuring collaboration beyond organizational boundaries. Innovation intermediaries have been shown to play a central role in enabling knowledge exchange across distributed innovation contexts (Feser, 2023; Hernández-Chea et al., 2021; Schepis et al., 2021), as they facilitate shared capacity development without undermining competitive positions. In the case of pharma, organizations like the Parenteral Drug Association (PDA) or the International Society for Pharmaceutical Engineering (ISPE) are well-positioned to identify cross-cutting capacity gaps and promote exchange. Since these platforms also include regulatory stakeholders like the U.S. Food and Drug Administration or the European Medicines Agency, they provide a space for technical and compliance perspectives to be aligned through shared dialogue. In addition, intermediaries can act as brokerage platforms that help initiate topic-specific consortia – for example, to develop shared data pools for rare diseases research. By offering such trusted platforms for coordination, they help align priorities in areas where individual efforts lack scale.

Together, these mechanisms enable a shift from fragmented, actor-level initiatives toward more deliberate coordination and lay the groundwork for improved alignment in subsequent transformation phases.

### 4.2.2 Sequencing capacity building along transformation phases

Despite a strong will to collaborate and a shared understanding that ecosystem-wide efforts would be beneficial, interviewees frequently described a difficulty of sequencing transformation in the absence of common reference points or integrated planning logic. As a result, capacities were often developed in isolation. To address this, we propose two mechanisms that support more deliberate alignment: ecosystem-wide orientation points, and holistic planning practices at the actor level.

*Benchmarks as shared orientation points:* Actors operating on different timelines can benefit from shared references that create visibility without enforcing uniformity. One promising approach is the use of benchmarking tools that reflect the interdependencies between capacity dimensions. In the pharmaceutical sector, self-assessment tools already exist to evaluate digital readiness on the technical level, often in the form of Excel-based checklists with built-in criteria and automated scoring (Banerjee et al., 2023). These tools could be further developed into validated maturity models that also incorporate organizational, regulatory, and strategic dimensions. Ideally, such models would be co-designed by industry associations and regulatory bodies to ensure relevance and legitimacy. When implemented across actors, they could make asynchronous developments visible and enable coordination around shared priorities. Building on such benchmarks, professional associations can also support implementation by offering respective training programs, thereby reducing the coordination burden on individual actors and strengthening system-wide readiness.

*Holistic capacity planning:* At the actor level, capacity-building efforts benefit from planning processes that reflect the full range of capacity dimensions. Interviewees described implementation processes as significantly more effective when cross-functional teams were involved. Building on this insight, such teams should already contribute to the planning phase to ensure that critical dependencies are addressed early. In particular, planning must account for organizational capacity: how new systems or practices are to be rolled out and stabilized across the organization. Internal structures such as transformation teams or designated change agents (Bellantuono et al., 2021) can support project teams in identifying what kind of organizational capacity is needed and how it can be built over time. In addition to functional and organizational integration, holistic planning also requires financial coherence. While project-based funding cycles often impede long-term investments, strategic co-funding arrangements can help align timelines and sustain momentum beyond initial pilot phases. Institutionalizing such planning approaches can improve internal alignment and reduce the risk of fragmented transformation efforts.

In sum, the practical implications of transitioning to an ecosystem model of capacity building requires both a mindset shift and institutional innovation. Leading pharmaceutical firms, in their role as ecosystem organizers, must move beyond viewing capacities as proprietary advantages and recognize that certain assets – such as standards or interfaces – are collective goods requiring joint investment. Regulatory agencies can play an equally vital role by creating enabling conditions for shared capacity development. They can leverage policy guidance or funding incentives that address all dimensions of capacity, enabling them to treat capacity-building outcomes as indicators of ecosystem health. When aligned through robust measurement and integrated implementation, these mechanisms can serve as critical enablers of a more resilient and innovation-ready ecosystem.

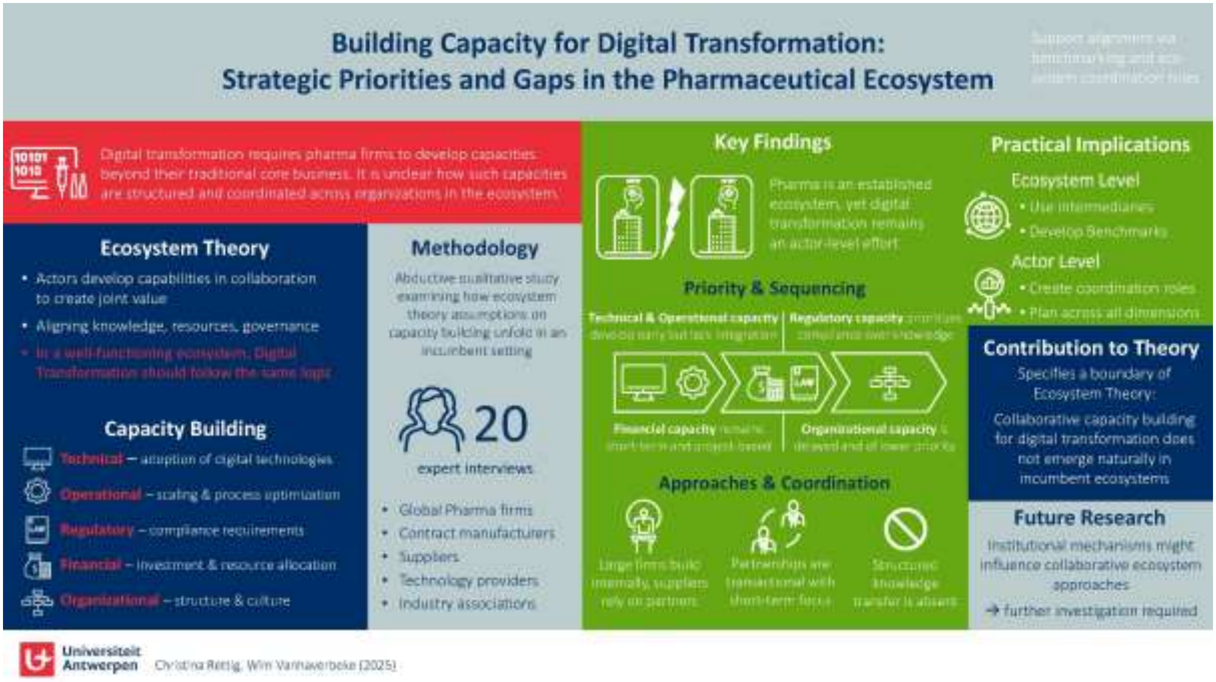
### 4.3 Summary & Outlook

This study examined how actors in the incumbent pharmaceutical ecosystem develop capacities for digital transformation, using a multidimensional framework informed by ecosystem theory, digital transformation research, and capacity building literature. From this conceptual basis, five core capacity dimensions were derived and empirically contextualized in terms of their relative priority, interdependence, and temporal development. Figure 1 offers a structured visual synthesis of the study, covering the research context, analytical lens, and key results.

Beyond its empirical insights, the study contributes in three ways. First, it refines ecosystem theory by specifying structural boundaries to spontaneous coordination in ecosystems centered around non-digital incumbents. Second, it introduces capacity building as a lens to trace the development and interplay of transformation-relevant conditions across actors and over time. Third, it offers practice-oriented insights into how shared frameworks and deliberate coordination mechanisms can support strategic alignment in digitally transforming ecosystems.

Building on these results, future research is needed to examine more closely the structural conditions under which collaborative capacity-building becomes viable in incumbent ecosystems. While the present study identifies capacity gaps and coordination challenges, it does not fully account for the deeper institutional pressures that shape ecosystem dynamics. These limitations may help explain why digital transformation initiatives, along with the building of the required capacities, often emerge at the organizational level but fail to scale ecosystem-wide. A follow-up study will therefore adopt a neo-institutional lens to explore how such forces constrain systemic alignment and collective action. This may offer a deeper understanding of the underlying dynamics and point to alternative pathways for ecosystem-wide transformation.

*Figure 1: Graphical Synopsis of the Study: Capacity Building for Digital Transformation in Pharma*




*Source: Own representation*

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